APPENDIX A

INTEGRATED CONSTRAINTS, REQUIREMENTS, AND ASSUMPTIONS FOR CASE 3S6E

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CONTENTS

TABLES

DEFINITIONS

Term	Definition
Basis	Something on which something else is established.
Constraint	Constraints are requirements from sources that are external to Tank Waste Remediation System (examples Tri-Party Agreement, Ecology, etc.)
Enabling Assumption	Assumptions required to permit work to proceed when information is not available (the missing information can be programmatic, technical, etc.)
Requirement	Requirements from sources internal to Tank Waste Remediation System (Decisions, Trade Studies, Request for Proposal, Contracts), or derived from other requirements or constraints.
Simplifying / Modeling Assumption	Assumptions required to maintain a manageable work scope

LIST OF TERMS

Acronym or Abbreviation	Meaning
BBI	Best-Basis Inventory
BNFL Inc.	British Nuclear Fuels Ltd. Inc.--a Phase 1 private contractor
CHG	CH2MHILL Hanford Group, Inc.
CLIN	Contract Line Item Number
CST	Contractor Support Team
DQO	Data Quality Objective(s)
DST	Double-Shell Tank
Ecology	Washington State Department of Ecology
ESP[1]	Environmental Simulation Program (thermodynamic computer model)
ESW	Enhanced Sludge Washing
ETF	Effluent Treatment Facility
FAE	Feed Availability Efficiency
FRD	Functions and Requirements Document
HLW	High-Level Waste
HTWOS	Hanford Tank Waste Operation Simulator
HWVP	Hanford Waste Vitrification Project
ICD	Interface Control Document
IHLW	Immobilized High-Level Waste
ILAW	Immobilized Low-Activity Waste
IMUST	Inactive Miscellaneous Underground Storage Tank
IPT	Integrated Product/Process Team
LAW	Feed for the Low-Activity Waste Plant
MOQ	Minimum Order Quantity
LMHC	Lockheed Martin Hanford Corporation
MYPP	Multi-Year Program Plan
NHC	Numatec Hanford Corporation
NVOL	Nonvolatile Solids
ORP	Office of River Protection
OSD	Operating Specification Document

1 ESP is a trademark of OLI Systems, Inc.

LIST OF TERMS

Acronym or Abbreviation	Meaning
OWVP	Operational Waste Volume Projection
PNNL	Pacific Northwest National Laboratory
PPTB	Privatization Process Technical Baseline
RCRA	*Resource Conservation and Recovery Act of 1976*
RFP	Request for Proposal
RPP	River Protection Project
SL	Safety Limit
SORWT	Sort on Radioactive Waste Type
SpG	Specific Gravity
SRP	Savannah River Plant
SST	Single-Shell Tank
TBD	To be determined
TEDF	Treated Effluent Disposal Facility
Tri-Party Agreement	*Hanford Federal Facility Agreement and Consent Order*
TRU	Transuranic
TWRS	Tank Waste Remediation System
TWRSO&UP	Tank Waste Remediation System Operation and Utilization Plan
USQ	Unreviewed Safety Question
WDOE	Washington Department of Ecology
WHC	Westinghouse Hanford Company
WRF	Waste Retrieval Facility
WTD	Waste Transfer Day
WV	West Valley
WVR	Waste Volume Reduction

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APPENDIX A

INTEGRATED CONSTRAINTS, REQUIREMENTS, AND ASSUMPTIONS FOR CASE 3S6E

A1.0 STRATEGY

A1.1 DOUBLE-SHELL TANK SYSTEM FUNCTIONS

This item is a:

	Constraint
X	Requirement
	Enabling Assumption
	Simplifying / Modeling Assumption

That applies to the:

	HLW Staging Plan
X	LLW Staging Plan
	Retrieval Sequence / Blending
	Process Flowsheet
	OWVP
	HTWOS
	DSS Inventory

Text of Item: The double-shell tank (DST) system will provide the required functions for Phase 1 operations. These functions are necessary and sufficient for the receipt of new waste into the system, waste storage, management of feed specifications, and waste feed delivery.

All operations to perform the system functions for privatization Phase 1 retrieval and processing must comply with the authorization basis when they are performed. In some cases, the authorization basis will need to be modified before the operations associated with a function are performed.

Source: *System Specification for the Double-Shell Tank System, Rev. 0* (Grenard 2000).

Issue: Functions requiring modification of the authorization basis need to be identified so that the authorization basis modifications can be developed and approved.

A1.2 PHASE 1B CONTRACTOR SPECIFIC DETAILS

This item is a:

	Constraint
	Requirement
	Enabling Assumption
X	Simplifying / Modeling Assumption

That applies to the:

X	HLW Staging Plan
X	LLW Staging Plan
X	Retrieval Sequence / Blending
X	Process Flowsheet
X	OWVP
X	HTWOS
X	DSS Inventory

Text of Item: BNFL Inc. performance will be modeled using the privatization contract requirements and/or RPP Key Planning Assumptions (PIO 2000).

Source: See Table 1.3-1 for a summary of BNFL performance assumptions.

Discussion: Privatization contract requirements will be used to model the private contractor's timing. Process details incorporated into the HTWOS model in conjunction with the Integrated Flowsheet task are not yet operational. The HTWOS model is limited on process detail at this time.

Issue: Since details of the private contractor plans have just been made available, some simplifying and modeling assumptions need to be made to fill in where the privatization contract, ICDs, and U.S. Department of Energy-Office of River Protection (ORP) planning guidance do not provide enough information to model the system. These assumptions will be documented in the various sections of this appendix.

A1.3 SAFETY ISSUE RESOLUTION

This item is a:

	Constraint
	Requirement
X	Enabling Assumption
	Simplifying / Modeling Assumption

That applies to the:

X	HLW Staging Plan
X	LLW Staging Plan
X	Retrieval Sequence / Blending
	Process Flowsheet
X	OWVP
X	HTWOS
	DSS Inventory

Text of Item: Safety and administrative issues concerning DST waste will be resolved in order to permit feed staging activities to occur as planned. It is assumed that flammable gas controls will be no more restrictive than the flammable gas controls as set forth in Appendix E of the *Tank Waste Remediation System Basis for Interim Operation* (Noorani 1998a). The limiting conditions for operation (LCOs) and administrative controls are found in the *Tank Waste Remediation System Technical Safety Requirements* (Noorani 1998b).

Issue: The majority of Envelope A feed planned to satisfy minimum order requirements is supplied from DSTs that are on the Watch List. Transfer of waste out of a hydrogen/flammable gas tank requires written approval by Nuclear Safety and DOE. This is a self-imposed requirement contained in the Operating Specification Document (OSD). It is not required by law or by the Authorization Basis. Transfer of waste into a watch-list tank requires written approval by the Secretary of Energy (OSD-T-151-00030, OSD 1997), which is required by the Wyden Bill. Therefore, it may be time consuming and difficult to get authorization to perform the required transfers for providing the feed to the private contractor.

The movement of large amounts of solids and consolidation of solids is not covered in the current authorization basis. This needs to be analyzed and added to the authorization basis. Possible changes to these assumptions may result.

Source: Noorani (1998a and 1998b).

A1.4 COMMON USE OF TRANSFER LINES

This item is a:

	Constraint
	Requirement
X	Enabling Assumption
	Simplifying / Modeling Assumption

That applies to the:

X	HLW Staging Plan
X	LLW Staging Plan
X	Retrieval Sequence / Blending
	Process Flowsheet
X	OWVP
X	HTWOS
	DSS Inventory

Text of Item: The use of a transfer line for one class of waste (high-level waste [HLW], transuranic [TRU] or DST supernate) does not preclude its use for a subsequent transfer involving another class of waste.

A1.5 GENERATION OF SINGLE-SHELL TANK RETRIEVAL SEQUENCES

This item is a:

	Constraint
	Requirement
X	Enabling Assumption
	Simplifying / Modeling Assumption

That applies to the:

	HLW Staging Plan
	LLW Staging Plan
X	Retrieval Sequence / Blending
	Process Flowsheet
	OWVP
X	HTWOS
	DSS Inventory

Text of Item: Candidate single-shell tank (SST) retrieval sequences (and schedules) will consider the values and measures listed in Table A-1.

Discussion: SST waste attributes that influence the generation of sequences are primarily the potential for reducing the probability of future groundwater contamination, saltcake versus sludge content of each tank, total sludge volume for an individual tank, total retrieved waste volume for an individual tank, inventory of glass limiting components, and listing on the SST Watch List.

Table A-1. SST Retrieval Measures Value Tree.

Top-level value	Value	Measure
Safety	Residual Waste	Quantity of waste remaining
Early retrieval to reduce long-lived, mobile radionuclides	Residual Waste	Quantity of waste remaining
Schedule	Tri-Party Agreement Milestones	Cumulative SST Retrieval Plot
		SST Retrieval Completion Variance
		HLW Process Completion Variance
		LAW Process Completion Variance
	Keep Plants Running	Cumulative throughput of LAW Pretreatment/ Vitrification Plants
		Cumulative downtime of LAW Pretreatment/ Vitrification Plants due to lack of feed
		Cumulative throughput of HLW Vitrification Plant
		Cumulative downtime of HLW Vitrification Plant due to lack of feed
Cost	HLW Glass Disposal	Immobilized HLW Volume
Funding Profile	SST Retrieval Capital	Capital cost profile of retrieval projects
Logistics	Complexity	Number of simultaneous transfers
		Number of simultaneous retrievals
	Resources - equipment	Number of sluicers required

HLW = High-level waste
LAW = Low-activity waste
SST = Single-shell tank.

A1.6 TRI-PARTY AGREEMENT SINGLE-SHELL TANK RETRIEVAL TARGET MILESTONES ARE TRADEABLE

This item is a:

	Constraint
	Requirement
X	Enabling Assumption
	Simplifying / Modeling Assumption

That applies to the:

	HLW Staging Plan
	LLW Staging Plan
X	Retrieval Sequence / Blending
	Process Flowsheet
	OWVP
	HTWOS
	DSS Inventory

Text of Item: *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement) (Ecology et al. 1996, as amended) Milestones M-45-05-T01 through M-45-05-T15 are considered tradeable with other measures and metrics including, but not limited to, cost profile, interim storage risk and high-level waste (HLW) glass volume.

Discussion: These milestones specify the number of (additional) SSTs for which retrieval must be initiated. This is reflected in a measure that is defined in the decision framework.

Making these milestones tradeable is consistent with past studies. Elevating SST retrieval in priority over Phase 1 waste processing resulted in having to idle the LAW processing facility for over a year. This idle time incurs penalty fees in excess of $220 million. The primary goal during Phase 1 will be to support operation of the processing facilities. SST wastes will be retrieved as DST space becomes available after satisfying Phase 1 feed staging requirements. New Tri-Party Agreement milestones will be negotiated after the decision to move ahead with privatization is made in August 2000.

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A2.0 MASTER SCHEDULE

A2.1 PHASE 1B TREATMENT START AND COMPLETION DATES

This item is a:

	Constraint
X	Requirement
	Enabling Assumption
	Simplifying / Modeling Assumption

That applies to the:

X	HLW Staging Plan
X	LLW Staging Plan
X	Retrieval Sequence / Blending
X	Process Flowsheet
X	OWVP
X	HTWOS
	DSS Inventory

Text of Item: Key start and completion dates are given in Table A-2.

Table A-2. Phase 1 Treatment Start and End Dates.

Activity	Date
First Batch of LAW Delivered	April 30, 2006
Start HLW Facility Hot Commissioning	May 31, 2007
Start HLW Hot Vitrification Services	September 1, 2008
Start LAW Facility Hot Commissioning	November 30, 2006
Start LAW Hot Vitrification Services	March 1, 2008
Complete Treatment Phase 1 Services	February 28, 2018

HLW = High-level waste
LAW = Low-activity waste.

Source: RPP Key Planning Assumptions (PIO 2000).

Issue: Fiscal Year (FY) 1999 planning guidance (Taylor 1998) states that Phase 2 processing should be assumed to start in 2012 (assumed to be October 1, 2011; FY 2012). That is over 6 years before the Phase 1 contract ends, and before the contract quantities of Phase 1 feed are processed. Recent guidance (PIO 2000) speaks to the Phase 2 processing rates but does not clarify start dates. See Section A2.4 for Phase 2 schedule assumptions.

A2.2 PHASE 1B DELIVERY AND TREATMENT SCHEDULE

This item is a:

	Constraint
X	Requirement
	Enabling Assumption
	Simplifying / Modeling Assumption

That applies to the:

X	HLW Staging Plan
X	LLW Staging Plan
X	Retrieval Sequence / Blending
	Process Flowsheet
X	OWVP
X	HTWOS
	DSS Inventory

Text of Item: CH2MHILL Hanford Group, Inc. (CHG) shall maintain the capability to provide quantities of LAW and HLW such that the cumulative units of LAW and the cummulative canisters of IHLW the BNFL Inc. may have processed by the end of each year of operation shall be at most 100 percent more than the cumulative plant performance profile from that year, provide that (i) DOE is not obligated to provide a total amount of LAW or HLW greater than the minimum order quantity (MOQ), and (ii) the amount shall not exceed 1,100 units of LAW or 120 canisters of IHLW.

Source: RL (1998) MOD. A010 (2000), Section H.

Discussion: The contract does not require processing to extend to the 2018 end date, but allows the privatization contractor to complete early processing of the minimum order quantity stipulated in the contract. The LAW processing may be completed as early as 2015, and the HLW processing may complete as early as 2013, based on the rates stipulated in the contract.

A2.3 PHASE 1B PLANTS - OPERATION BEYOND MINIMUM ORDER QUANTITIES

This item is a:

	Constraint
	Requirement
	Enabling Assumption
X	Simplifying / Modeling Assumption

That applies to the:

X	HLW Staging Plan
X	LLW Staging Plan
X	Retrieval Sequence / Blending
	Process Flowsheet
	OWVP
X	HTWOS
	DSS Inventory

Text of Item: The BNFL Inc. Phase 1 LAW and HLW plants will be used to process the Phase 1 minimum order quantities and then will continue to operate until the contract expires (2/28/2018).

Source: RL (1998) as amended, Taylor (1999), PIO 2000.

Discussion: The contract allows until February 28, 2018, for BNFL Inc. to process the current contract order quantity (referred to as minimum order quantity). If BNFL Inc. can process at or near the maximum allowed rates, they will finish the minimum order quantity and then be given the opportunity to process additional waste within the time limit of the contract. CHG has identified wastes that can be delivered to BNFL Inc. for processing after the minimum order quantity has been completed and before the contract expires. These candidate feed sources are referred to as extended order wastes.

A2.4 PHASE 2 FULL-SCALE OPERATION

This item is a:

	Constraint
	Requirement
X	Enabling Assumption
	Simplifying / Modeling Assumption

That applies to the:

	HLW Staging Plan
	LLW Staging Plan
X	Retrieval Sequence / Blending
X	Process Flowsheet
	OWVP
X	HTWOS
	DSS Inventory

Text of Item: Phase 2 operations will start on March 1, 2018. One additional LAW plant and one additional HLW plant will be built to support Phase 2 operations. The BNFL Inc. LAW and HLW plants will be expanded to increase their capacity to support Phase 2 operations. Both of the Phase 2 LAW plants will have a capacity approximately twice that of the BNFL Inc. Phase 1 LAW plant for a total LAW capacity of 120 MT ILAW per day; approximately four times the Phase 1 LAW capacity. Both of the Phase 2 HLW plants will have capacity approximately four times that of the BNFL Inc. Phase 1 HLW plant for a total HLW capacity of 12 MT IHLW per day; approximately eight times the Phase 1 HLW capacity.

Discussion: Past direction for Phase 2 (Taylor 1998) has been to add one LAW plant to double the total LAW processing capacity and expand the Phase 1 HLW plant to quadruple the total HLW capacity. The most recent direction given almost doubles the total Phase 2 capacities. Wastes from SSTs will be retrieved during the Phase 1 to backfill available DST space and provide feed for the Phase 2 facilities. The March 1, 2018 start date for Phase 2 operations was derived from the BNFL Inc. contract end date of February 28, 2018.

Issue: The second Phase 2 LAW plant (pretreatment and vitrification) may need to start operation before March 1, 2018 and the HLW pretreatment capacity may need to increase before March 1, 2018 to support the proposed increase in HLW vitrification capacity. Phase 2 facility starts and operating capacities will be adjusted as necessary to support the desired capacity increases for Phase 2 starting March 1, 2018. This need to bring facilities on-line before March 1, 2018 may be an artifact of how the Phase 1 to Phase 2 transition is modeled and can be corrected when further detail about the transition becomes available.

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A3.0 DOUBLE-SHELL TANK SYSTEM

A3.1 WASTE COMPATIBILITY

This item is a:

	Constraint
X	Requirement
	Enabling Assumption
	Simplifying / Modeling Assumption

That applies to the:

X	HLW Staging Plan
X	LLW Staging Plan
	Retrieval Sequence / Blending
	Process Flowsheet
X	OWVP
?	HTWOS
X	DSS Inventory

Text of Item: Waste compatibility requirements, documented in *Data Quality Objectives for Tank Farms Waste Compatibility Program* (Mulkey 1997) and *Tank Farm Waste Transfer Compatibility Program* (Fowler 1999), will be used to determine if transfers of waste within the DST system are permissible (see Item 3.2 for disposition of issues). However, DOE has granted exemptions for both complexed waste segregation and TRU waste blending immediately prior to treatment and disposal. Therefore, those exemptions will also be taken into account.

Source: Fowler (1999), Mulkey et al. (1999), Kinser (1998) and Taylor (1996).

Discussion: The Fowler and Mulkey documents consolidate requirements from various sources into a set of decision rules. The rules consider criticality, flammable gas accumulation, energetics, corrosion, watch-list tanks, chemical compatibility, tank waste type, TRU waste segregation, heat generation rate, complexant waste segregation, waste pumpability and high phosphate waste. DOE has granted exemptions for both complexed waste segregation and TRU waste blending immediately prior to treatment and disposal.

Issue: The *Low-Level Waste Feed Staging Plan* (Certa et al. 1996b) identified three rules that may present problems. They are: (1) TRU Segregation, (2) Complexed Waste Segregation, and (3) Tank Waste Type. New data for the TRU segregation and complexed waste segregation have been discussed above lessening the severity of the issue. But, there are still complications associated with mixing those wastes as discussed above.

Source: Certa et al. (1996b).

Issue: The context under which the decision rules were developed was that of waste management (receipt, storage, transfer, and concentration of waste). These may not be valid under a processing context (retrieval, in-process storage, partial pretreatment followed by removal from the DST system).

A3.2 WASTE COMPATIBILITY ISSUE RESOLUTION

This item is a:

	Constraint
	Requirement
X	Enabling Assumption
	Simplifying / Modeling Assumption

That applies to the:

X	HLW Staging Plan
X	LLW Staging Plan
X	Retrieval Sequence / Blending
X	Process Flowsheet
X	OWVP
X	HTWOS
X	DSS Inventory

Text of Item: The disposition of the waste compatibility issues raised by the *Low-Level Waste Feed Staging Plan* (Certa et al. 1996b) will be as follows:

1. **Transuranic (TRU) Segregation**: An evaluation determined that segregation of tank wastes potentially classified as TRU from other wastes during treatment and disposal is not required (Taylor 1996). However, the TRU waste is not to be mixed with a waste that meets one of the Phase 1 feed specifications if the resulting waste will not meet the Phase 1 feed specification.

2. **Complexed Waste Segregation**: An evaluation determined that there is no Waste Volume Reduction (WVR) penalty since this waste is being removed from the DST system and doesn't require further evaporation and storage. DOE-RL has granted permission to allow complexed waste to be mixed with non-complexed waste based upon meeting certain conditions, and obtaining DOE-RL approval for mixing the waste on a case by case basis (Kinser 1998).

3. **Tank Waste Type**: An evaluation of staging activities finds that tank heels may be neglected when applying the waste compatibility matrix.

Additionally, two rules will be complied with that were problematic in the *Preliminary Low-Level Waste Feed Staging Plan* (Certa et al. 1996a). Both of these rules are Authorization Basis issues with specific accidents identified in Noorani (1998a), and the associated controls established in Noorani (1998b). The rules and associated control may change when the waste feed activities have been evaluated and any changes to the Authorization Basis have been implemented.

4. **Flammable Gas Accumulation**: This rule will not be relaxed and will be followed. Feed staging transfers that could violate the SpG rule will be diluted before or during transfer. Sufficient dilution water will be added to reduce the SpG to 1.40 or lower (the rule specifies 1.41).

5. **Heat Generation Rate**: This rule will not be relaxed and will be followed.

Discussion:

1. **TRU Segregation**: The DOE Order for TRU segregation was meant to minimize disposal costs by keeping the volume of TRU waste to a minimum. DOE-RL concurred with a Westinghouse Hanford Company evaluation that segregation of TRU wastes from other HLW streams during treatment and disposal is not required because of the additional costs associated with immobilization of segregated TRU waste. Since staging of wastes is considered to be part of the treatment and disposal process, segregation during feed staging will not be required. However, the TRU waste is not to be mixed with a waste that meets one of the Phase 1 feed specifications if the resulting waste will not meet the Phase 1 feed specification.

2. **Complexed Waste Segregation**: This rule is to avoid mixing waste, which will cause an unwanted WVR penalty. If the WVR penalty is acceptable, or non-existent, this rule can be overridden.

   DOE-RL has provided guidance (Kinser 1998) that allows complexed waste to be mixed with other wastes if it does not cause the waste to go outside the current limits of the privatization feed envelopes.

3. **Tank Waste Type**: The issue of tank heels is not addressed in the current Compatibility Program or Data Quality Objective (DQO). In practice, tank heels have not been deemed to designate the waste type of a tank. Tanks pumped to a minimal heel are usually considered empty. If, however, there is a safety concern with adding a particular waste type to a heel of another type then the heel cannot be neglected. Tank heels is one of the issues that Process Engineering have suggested be addressed in a future revision of the Compatibility Program.

Source: Fowler (1999), Fowler (1996b), Taylor (1996) and Kinser (1998).

Issue: Negotiations with RL and Ecology concerning the content of the Waste Compatibility DQO are in progress. There may be an opportunity to explicitly address waste transfers required for feed staging purposes and structure the DQO accordingly.

A3.3 MAXIMUM MODELED DOUBLE-SHELL TANK LIQUID LEVEL

This item is a:

	Constraint
	Requirement
X	Enabling Assumption
	Simplifying / Modeling Assumption

That applies to the:

X	HLW Staging Plan
X	LLW Staging Plan
X	Retrieval Sequence / Blending
X	Process Flowsheet
X	OWVP
X	HTWOS
X	DSS Inventory

Text of Item: The DSTs cannot be filled above the maximum liquid levels shown in Table A-3.

Table A-3. Double-Shell Tank Modeled Volume Limits.

Double-shell tanks	Modeled Maximum
AN-, AP-, AW- and SY-Farms except 241-AW-102	4,330 m^3 (416 in)
241-AW-102	4,270 m^3 (410 in)
AY- and AZ- Tank Farms	3,790 m^3 (364 in)

Discussion: No upper volume limits (e.g. Safety Limit, Limiting Control Setting, or Limiting Condition Operation) are currently listed in the Tank Farms Operating Specifications documents (including the TWRS BIO) for the DSTs. Modeled DST upper limits are based on current operating procedures and practices. Current operating practices remain unchanged from prior practices, which followed specifications summarized in the previous revision of this document.

Source: Personal communication with R. A. Dodd (CH2M Hill Hanford Group), October 28, 1998.

Source: Kirkbride et al. (1999).

Issue: No DST upper volume limits are currently cited in the Tank Farms Operating Specifications documents (including the TWRS BIO).

A3.4 MINIMUM DOUBLE-SHELL TANK LIQUID LEVEL

This item is a:

	Constraint
X	Requirement
	Enabling Assumption
	Simplifying / Modeling Assumption

That applies to the:

X	HLW Staging Plan
X	LLW Staging Plan
X	Retrieval Sequence / Blending
X	Process Flowsheet
X	OWVP
X	HTWOS
X	DSS Inventory

Text of Item: The waste or liquid volume in AN, AP, AW, and SY Tank Farm DSTs will not be pumped down less than 60 m^3 (0.15 m [6 in.]). The waste or liquid volume in AY and AZ Tank Farm DSTs will not be pumped down less than 670 m^3 (1.6 m [64 in.]) when the annulus ventilation system is operating.

Source: OSD-T-151-00007, Rev. H-21 (WHC 1996).

Issue: The standard operating procedure is to maintain a minimum liquid level of 1.93 m (76-in.) for storing waste in the AY and AZ tanks.

Issue: The minimum liquid level discussed here is the minimum operating level per the procedures. If solids remain in a tank, safety analysis may require greater liquid depth to prevent a tank bump.

A3.5 ACHIEVABLE DOUBLE-SHELL TANK HEELS

This item is a:

	Constraint
	Requirement
X	Enabling Assumption
	Simplifying / Modeling Assumption

That applies to the:

X	HLW Staging Plan
X	LLW Staging Plan
X	Retrieval Sequence / Blending
X	Process Flowsheet
X	OWVP
X	HTWOS
X	DSS Inventory

Text of Item: DSTs will be pumped down to a 100 m^3 (0.25-m [10-in.]) heel when removing waste. The 0.25-m (10-in.) heel will be measured above a settled solids layer when decanting and above the bottom of a tank when emptying a tank. The annulus ventilation will be shut off when pumping AZ and AY farm DSTs below 670 m^3 (1.6 m [64 in.]).

The presence of failed equipment in a tank will not adversely affect the assumed heel volumes.

Discussion: The current floating suction pumps will stop pumping with about 100 m^3 to 420 m^3 (0.25 m to 1 m [10 to 40 in.]) of waste remaining in the tank. The pump will lose prime below 750 m^3 (1.83 m [72 in.]) if turned off.

Source: Verbal discussion, M. R. Elmore, D. A. Burbank, J. L. Foster.

Discussion: A new decant pump can probably pump within 0.1 ML (0.25 m [10 in.]) of the bottom of the tank or solids level. This is consistent with performance observed during a vendor test of the pump.

Source: T. W. Staehr and H-2-820774, Piping Decant Pump Assembly Elevation and Details, Sheets 1 and 2, Rev. 1.

Discussion: The inlet of most deep-well turbine pumps is about 0.1 ML (0.25 m [10 in.]) from the bottom.

Issue: Available net positive suction head may be reduced by elevated waste temperatures and the pumps may not be able to reach the minimum heels assumed here.

A3.6 PHASE 1B SOLIDS DECANT HEEL

This item is a:

	Constraint
	Requirement
	Enabling Assumption
X	Simplifying / Modeling Assumption

That applies to the:

X	HLW Staging Plan
X	LLW Staging Plan
X	Retrieval Sequence / Blending
	Process Flowsheet
	OWVP
X	HTWOS
	DSS Inventory

Text of Item: The elevation of settled solids is assumed to be uniform and it is assumed that the supernate will be decanted down to 100 m^3 (0.25 m [10 in.]) above any settle solids layer when decanting liquids. This prevents inadvertent uptake of settled solids.

Source: Winkler (1993).

Issue: The elevation of solids in all tanks will be uneven, and in tanks with mixer pumps, the variation may be even greater. The control system for the new floating suction decanting pumps will be designed so that the pumps will shut off when the clarity of the supernatant being pumped rises above 100 ppm, as measured by the turbidity sensor. The intake design of the pump will most likely limit the pumpdown to 0.25 m to 0.3 m (10 in. to 12 in.) above the settled solids layer. However, the clarity of the supernatant could be more restrictive.

A3.7 DOUBLE-SHELL TANK USAGE ALLOCATION

This item is a:

	Constraint
	Requirement
X	Enabling Assumption
	Simplifying / Modeling Assumption

That applies to the:

	HLW Staging Plan
X	LLW Staging Plan
X	Retrieval Sequence / Blending
X	Process Flowsheet
X	OWVP
X	HTWOS
	DSS Inventory

Text of Item: The DSTs will be allocated for specific uses as given in Table A-4.

Discussion: General schedule guidance is given in the table to direct the modeling effort. Specific schedules are determined by running the HTWOS model.

Table A-4. Double-Shell Tank Usage Allocation. (3 Sheets)

Tank	Allocation	Time period
AN-101	SWL Receiver - Cascade SWL to AN-106 - Evaporate if necessary and send concentrate to AN-106.	Until SWL is done, approximately 2003 HTWOS determines evaporation schedule
	Cleanout and use for LAW feed staging	Until LAW Batch 17 is delivered
	Phase 2 staging	Through the end of Phase 2
AN-102	LAW feed source (staging)	
	- Caustic addition	TBD
	- Phase 1 feed staging	Start delivery when half of Envelope B is processed.
	- Tank cleanout, if necessary	After LAW Batch 4 is delivered
	- Phase 1 LAW feed staging	Until LAW Batch 18 is delivered
	- Phase 2 staging	Through the end of Phase 2
AN-103	LAW feed source (staging)	Until LAW Batch 13 is delivered
	Phase 2 staging	Through the end of Phase 2
AN-104	LAW feed source (staging)	Until LAW Batch 5 is delivered
	Slurry cross-site receiver (unless needed for feed staging)	Through the end of Phase 2
AN-105	LAW feed source (staging)	Until LAW Batch 21 is delivered
	Phase 2 staging	Through the end of Phase 2
AN-106	SWL receiver - Cascade from AN-101 - Evaporate if necessary - Receive concentrated waste	Until SWL done, approximately 2003 HTWOS determines Evaporation schedule
	Phase 2 staging	Through the end of Phase 2
AN-107	LAW feed source (staging) - Caustic addition	Until LAW Batch 7 is delivered TBD
	Phase 2 staging	Through the end of Phase 2
AP-101	LAW feed source (staging)	Until LAW Batch 20 is delivered
	Phase 2 staging	Through the end of Phase 2
AP-102	Backup LAW feed source; keep empty if feed is used	Through the end of Phase 1

Table A-4. Double-Shell Tank Usage Allocation. (3 Sheets)

Tank	Allocation	Time period
	Phase 2 feed source (staging)	Through the end of Phase 2
AP-103	Concentrated waste receiver (evaporator bottoms)	From approximately the end of FY 2000 until full
	Phase 2 feed source and staging	Through the end of Phase 2
AP-104	Receiver for SY-101 initial mitigation retrieval	Until approximately 1/2000
	LAW feed source and staging (Batches 10, 16, and 22)	Until LAW Batch 22 is delivered
	Phase 2 staging	Through the end of Phase 2
AP-105	Concentrated waste receiver (evaporator bottoms)	From approximately end of FY 2000 until full
	LAW feed source	Until LAW Batch 23 is delivered
	Phase 2 staging	Through the end of Phase 2
AP-106	SWL receiver - Evaporate if necessary - Return concentrated waste to tank	Until SWL is done, approximately 2003 HTWOS determines evaporation schedule
	LAW feed source	Until LAW Batch 19 is delivered
	Phase 2 staging	Through the end of Phase 1
AP-107	SWL cross-site receiver (from SY-102)	Until approximately 2004
	Concentrated waste receiver or cross-site receiver, as needed by HTWOS	Through the end of Phase 2
AP-108	Miscellaneous waste receiver	Until approximately 2009
	LAW feed staging (concentrated waste)	Until LAW Batch 24 is delivered
	Phase 2 staging	Through the end of Phase 2
AW-101	LAW feed source (staging)	Until LAW batch 15 is delivered
	Phase 2 staging	Through the end of Phase 2
AW-102	Evaporator feed tank	Through the end of Phase 2
AW-103	HLW feed source - Use non-complexed, low phosphate waste as transport fluid - May use tank as concentrated waste receiver if needed	Until retrieval of waste to AW-104 is complete (HLW Batches 45 to 50)
	Phase 2 staging	Through the end of Phase 2
AW-104	Waste storage - Evaporate supernate and return to tank - Slurry feed receiver, as needed	Until AW-103 retrieval for HLW batches 45-50.
	LAW feed source	Until supernate is transferred to AP-104 to prepare LAW Batch 16
	HLW feed source (staging)	Until HLW Batch 50 is delivered
	Phase 2 staging	Through the end of Phase 2
AW-105	100 Area terminal cleanout receiver - Includes TRU solids - Remove dilute supernate as tank fills and concentrate through evaporator - Concentrated waste can go to concentrated waste receivers	Until approximately 2008
	Potential Phase 1 HLW feed source	HTWOS determines if needed
	Phase 2 staging	Through the end of Phase 2
AW-106	Evaporator bottoms receiver tank	Through the end of Phase 2

Table A-4. Double-Shell Tank Usage Allocation. (3 Sheets)

Tank	Allocation	Time period
AY-101	Waste storage	Until C-104 retrieval starts
	C-104 sluicing receiver	Until C-104 retrieval is complete
	HLW feed source (staging)	Until HLW Batch 31 is delivered
	Phase 2 staging (and SST sluicing receiver if needed)	Through the end of Phase 2
AY-102	C-106 sluicing receiver	Until C-106 retrieval is done
	HLW feed source (staging)	Until HLW Batch 19 is delivered
	C-107 sluicing receiver	Until C-107 retrieval is done
	HLW feed source (staging) (includes AW-103 waste)	Until HLW Batch 44 is delivered
	Phase 2 SST sluicing receiver and staging	Through the end of Phase 2
AZ-101	LAW and HLW feed source (staging)	Until HLW Batch 6 is delivered
	HLW feed staging	Until HLW Batch 35 is delivered
	Phase 2 staging	Through the end of Phase 2
AZ-102	LAW and HLW feed source (staging)	Until HLW Batch 12 is delivered
	Kept empty as backup LAW/HLW feed staging tank	Until the end of Phase 1
	Phase 2 staging	Through the end of Phase 2
SY-101	LAW feed source - Approximately 300 kgal to AP-104 initial mitigation retrieval - Remainder retrieved to AN-101	Until retrieved to AN-101 for LAW Batch 11
	Phase 2 staging -West Area SST sluicing receiver - West to East cross-site staging tank - West Area cross-site receiver	Through the end of Phase 2
SY-102	Cross-site transfers - West Area receiver - West to East cross-site staging tank	Until approximately 2004
	HLW feed source	Until retrieved to AZ-101 to make HLW Batches 32-35
	Phase 2 staging - West Area SST sluicing receiver - West to East cross-site staging tank - West Area cross-site receiver	Through the end of Phase 2
SY-103	LAW feed source	Until retrieved to AN-101 to make LAW Batch 17
	Phase 2 staging - West Area SST sluicing receiver - West to East cross-site staging tank - West Area cross-site receiver	Through the end of Phase 2

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A4.0 FEED COMPOSITIONS

A4.1 PHASE 1B LOW-ACTIVITY WASTE FEED COMPOSITION

This item is a:

	Constraint
X	Requirement
	Enabling Assumption
	Simplifying / Modeling Assumption

That applies to the:

	HLW Staging Plan
X	LLW Staging Plan
X	Retrieval Sequence / Blending
X	Process Flowsheet
X	OWVP
X	HTWOS
	DSS Inventory

Text of Item: LAW Waste supplied to the private contractor during the Phase 1B meets the limits established by feed Envelopes A-C per the privatization contract. The specification tables from the contract are reproduced in Tables A-5 and A-6. One exception is that the maximum ^{137}Cs concentration equivalent in the transferred LAW feed shall be less than 1.2 Ci/L instead of the 6 Ci/L as currently stated in the BNFL Inc. contract. The maximum ^{137}Cs concentration in the liquid fraction of waste in tanks 241-AZ-101 and –102 shall not exceed 3.0 Ci/L.

Table A-5. BNFL Inc. Contract Specification Table TS-7.1, LAW Chemical Composition, Soluble Fraction Only.

Chemical Analyte	Maximum ratio, analyte (mole) to sodium (mole)		
	Envelope A	Envelope B	Envelope C
Al	2.5E-01	2.5E-01	2.5E-01
Ba	1.0E-04	1.0E-04	1.0E-04
Ca	4.0E-02	4.0E-02	4.0E-02
Cd	4.0E-03	4.0E-03	4.0E-03
Cl	3.7E-02	8.9E-02	3.7E-02
Cr	6.9E-03	2.0E-02	6.9E-03
F	9.1E-02	2.0E-01	9.1E-02
Fe	1.0E-02	1.0E-02	1.0E-02
Hg	1.4E-05	1.4E-05	1.4E-05
K	1.8E-01	1.8E-01	1.8E-01
La	8.3E-05	8.3E-05	8.3E-05
Ni	3.0E-03	3.0E-03	3.0E-03
NO_2	3.8E-01	3.8E-01	3.8E-01
NO_3	8.0E-01	8.0E-01	8.0E-01
Pb	6.8E-04	6.8E-04	6.8E-04
PO_4	3.8E-02	1.3E-01	3.8E-02
SO_4	1.0E-02	7.0E-02	2.0E-02
TIC[1]	3.0E-01	3.0E-01	3.0E-01
TOC[2]	5.0E-01	5.0E-01	5.0E-01
U	1.2E-03	1.2E-03	1.2E-03

[1]Mole of inorganic carbon atoms/mole sodium
[2]Mole of organic carbon atoms/mole sodium.

Table A-6. BNFL Inc. Contract Specification Table TS-7.2, LAW Radionuclide Content,[1] Soluble Fraction Only.

Radionuclide	Maximum ratio, radionuclide (Bq) to sodium (mole)		
	Envelope A	Envelope B	Envelope C
TRU[2]	4.8E+05	4.8E+05	3.0E+06
^{137}Cs	4.3E+09	2.0E+10	4.3E+09
^{90}Sr	4.4E+07	4.4E+07	8.0E+08
^{99}Tc	7.1E+06	7.1E+06	7.1E+06
^{60}Co	6.1E+04	6.1E+04	3.7E+05
^{154}Eu plus ^{155}Eu	1.2E+06	1.2E+06	4.3E+06

[1]The activity limit shall apply to the feed certification date.
[2]TRU is defined in accordance with 10 CFR Part 61.55.

Some radionuclides, such as ^{90}Sr and ^{137}Cs, have daughters with relatively short half-lives. These daughters have not been listed in this table. However, they are present in concentrations associated with the normal decay chains of the radionuclides.

Source: DOE-RL (1996) MOD. A012 (2000), Section C.6, Specification 7.

Discussion: The original envelope concept was established by McKee et al. (1995): "Envelope A represents waste that will test the production capacity and fission product removal efficiency of the plants while producing a final product in which the waste loading will be limited by sodium. Envelope B waste is similar to Envelope A but this waste will produce a final product in which the waste loading will be limited by minor component concentrations. Envelope C represents waste with complexing agents that may interfere with ^{90}Sr and/or TRU decontamination requiring demonstration of organic destruction or some other acceptable mitigation technology."

The development of the current envelopes is described by Patello et al. (1996).

The CHG will plan to deliver feed which meets the privatization contract specifications. If the feed does not meet the specifications, it will be processed under contract clause H.43. There are no plans to dilute or shim any out-of-specification feed.

Issue: All waste meeting Envelope A requirements will also satisfy Envelope B and Envelope C requirements

Issue: An emerging issue is that 22 DSTs received plutonium-uranium extraction (PUREX) organic wash waste based on transaction records through January 1, 1994 (Agnew 1996). This means that there could be soluble tributyl phosphate or separate phase PUREX-type solvent in the supernate in some DSTs. The DSTs identified in Agnew's report include 241-AN-101 through 241-AN-107, 241-AP-101 through 241-AP-103, 241-AP-105, 241-AP-106, 241-AP-108, 241-AW-101, 241-AW-102, 241-AW-105, 241-AW-106, 241-AY-101, 241-AZ-101, 241-AZ-102, 241-SY-101, and 241-SY-103. Some of these are candidate tanks for privatization Phase 1 feed. Additionally, in 1985 B. M. Mauss observed that a surface sample from 241-AW-105 contained an organic phase (Herting 1990). Waste with a visible organic layer does not meet the contract specification.

Source: DOE-RL (1996) MOD. A012 (2000), Specification 7.

Issue: Maximum source terms, both radiological and toxicological must be developed to support development of the safety basis and authorization basis amendment.

A4.2 PHASE 1B HIGH-LEVEL WASTE FEED COMPOSITION

This item is a:

	Constraint
X	Requirement
	Enabling Assumption
	Simplifying / Modeling Assumption

That applies to the:

X	HLW Staging Plan
	LLW Staging Plan
	Retrieval Sequence / Blending
	Process Flowsheet
	OWVP
	HTWOS
	DSS Inventory

Text of Item: The unwashed solids composition of the HLW slurry feed supplied to the private contractor during Phase 1 will satisfy the composition limits established by waste Envelope D. The slurry will contain a mixture of liquids (Envelopes A, B, or C) and solids (Envelope D). The compositional range of the liquid fraction is defined in Specification 7 (see Section 4.1). In Specification 8 only components identified in Tables TS-8.1, TS-8.2, and TS-8.3 have concentration limits which will be used to provide the basis for certification that HLW solids are within specification limits. The feed concentration will be between 10 and 200 grams of unwashed solids per liter of slurry. The Envelope D feed specification tables are reproduced as Tables A-7, A-8, and A-9. Table A-10 has limits on components that are important to HLW glass production. The concentration of the components are not expected to be exceeded. The following exceptions to the BNFL contract will be allowed. The minimum HLW solids concentration requirement to be greater than 10 g/L is waived for tanks 241-AZ-101 and 241-AZ-102. The sodium concentration in the LAW feed delivered from tanks 241-AZ-101 and 241-AZ-102 can range between 2*M* and 5*M*. The sodium concentration in the liquid fraction of HLW slurries can range between 0.1*M* and 10*M*.

The CHG will plan to deliver feed that meets the privatization contract specifications. If the feed does not meet the specifications, it will be processed under contract clause H.43. There are no plans to dilute or shim any out-of-specification feed, or to have contingency feed available.

Table A-7. BNFL Inc. Contract Specification Table TS-8.1 High-Level Waste Feed Unwashed Solids Maximum Non-Volatile Component Composition
(grams per 100 grams non-volatile waste oxides)

Non-volatile element	Maximum (grams/100 grams waste oxides)	Non-volatile element	Maximum (grams/100 grams waste oxides)
As	0.16	Pu	0.054
B	1.3	Rb	0.19
Be	0.065	Sb	0.84
Ce	0.81	Se	0.52
Co	0.45	Sr	0.52
Cs	0.58	Ta	0.03
Cu	0.48	Tc	0.26
Hg	0.1	Te	0.13
La	2.6	Th	0.52
Li	0.14	Tl	0.45
Mn	6.5	V	0.032
Mo	0.65	W	0.24
Nd	1.7	Y	0.16
Pr	0.35	Zn	0.42

Table A-8. BNFL Inc. Contract Specification Table TS-8.2 High-Level Waste Feed Unwashed Solids Maximum Volatile Component Composition.
(grams per 100 grams non-volatile waste oxides)

Volatile components	Maximum (grams / 100 grams waste oxides)
Cl	0.33
CO_3^{-2}	30
NO_2	36 (total NO_2/NO_3) as NO_3
NO_3	
TOC	11
CN	1.6
NH_3	1.6

Table A-9. BNFL Inc. Contract Specification Table TS-8.3 High-Level Waste Feed Unwashed Solids Maximum Radionuclide Composition.
(Curies per 100 grams non-volatile waste oxides)

Isotope	Maximum (Ci/100 grams waste oxides)	Isotope	Maximum (Ci/100 grams waste oxides)	Isotope	Maximum (Ci/100 grams waste oxides)
^{3}H	6.5E-05	^{129}I	2.9E-07	^{237}Np	7.4E-05
^{14}C	6.5E-06	^{137}Cs	1.5E+00	^{238}Pu	3.5E-04
^{60}Co	1E-02	^{152}Eu	4.8E-04	^{239}Pu	3.1E-03
^{90}Sr	1E+01	^{154}Eu	5.2E-02	^{241}Pu	2.2E-02
^{99}Tc	1.5E-02	^{155}Eu	2.9E-02	^{241}Am	9.0E-02
^{125}Sb	3.2E-02	^{233}U	9.0E-07	$^{243+244}Cm$	3.0E-03
^{126}Sn	1.5E-04	^{235}U	2.5E-07		

Table A-10. BNFL Inc. Contract Specification Table TS-8.4 Additional High-Level Waste Feed Composition for Non-Volatile Components.
(Grams per 100 grams non-volatile waste oxides)

Non-volatile element	Maximum (grams / 100 grams waste oxides)	Non-volatile element	Maximum (grams / 100 grams waste oxides)
Ag	0.55	Ni	2.4
Al	14	P	1.7
Ba	4.5	Pb	1.1
Bi	2.8	Pd	0.13
Ca	7.1	Rh	0.13
Cd	4.5	Ru	0.35
Cr	0.68	S	0.65
F	3.5	Si	19
Fe	29	Ti	1.3
K	1.3	U	14
Mg	2.1	Zr	15
Na	19		

Source: DOE-RL (1996) MOD. A006 (1998), Section C, Specification 8, Taylor (1999).

Issue: The maximum solids loading of the feed will also be limited by the Authorization Basis analyzed releases for spray leak, surface leak, and subsurface leaks. This analysis has not been performed at the current time.

Issue: Maximum source terms, both radiological and toxicological must be developed to support development of the safety basis and authorization basis amendment.

A4.3 PHASE 2 FEED COMPOSITION

This item is a:

	Constraint
	Requirement
	Enabling Assumption
X	Simplifying / Modeling Assumption

That applies to the:

	HLW Staging Plan
	LLW Staging Plan
X	Retrieval Sequence / Blending
	Process Flowsheet
	OWVP
X	HTWOS
	DSS Inventory

Text of Item: There are no feed envelope specifications that have to be met during Phase 2.

Discussion: Envelopes developed for Phase 1B do not apply to the broader range of waste expected during Phase 2 and no feed envelopes have been defined for Phase 2.

A5.0 FEED DELIVERY

A5.1 PHASE 1B ORDER QUANTITIES

This item is a:

	Constraint
X	Requirement
	Enabling Assumption
	Simplifying / Modeling Assumption

That applies to the:

X	HLW Staging Plan
X	LLW Staging Plan
X	Retrieval Sequence / Blending
X	Process Flowsheet
X	OWVP
X	HTWOS
	DSS Inventory

Text of Item: A minimum of 6,000 units of LAW feed meeting requirements for LAW Envelopes A, B, and C shall be delivered to BNFL Inc. The quantity of Envelope C waste shall not exceed 2,100 units unless agreed to by BNFL Inc. Units of LAW feed are defined in contract specification 7.2.3. The CHG must supply sufficient HLW feed meeting HLW Envelope D to produce 600 canisters of HLW glass.

A5.2 PHASE 1B PRIVATE CONTRACTOR NOTICE

This item is a:

	Constraint
X	Requirement
	Enabling Assumption
	Simplifying / Modeling Assumption

That applies to the:

X	HLW Staging Plan
X	LLW Staging Plan
	Retrieval Sequence / Blending
	Process Flowsheet
	OWVP
	HTWOS
	DSS Inventory

Text of Item: The private contractor will provide notice 60 days in advance of the desired waste transfer date (WTD) and promptly inform ORP if the WTD will change.

Source: ICD 19, Washer (2000).

A5.3 PHASE 1B FEED DELIVERY WINDOW

This item is a:

	Constraint
X	Requirement
	Enabling Assumption
	Simplifying / Modeling Assumption

That applies to the:

X	HLW Staging Plan
X	LLW Staging Plan
X	Retrieval Sequence / Blending
	Process Flowsheet
X	OWVP
X	HTWOS
	DSS Inventory

Text of Item: The CHG will deliver each batch of feed to the private contractor: (1) beginning no earlier than the later of the WTD or the day that contractor is actually ready to receive feed and (2) finishing no later than 30 days after the ready date.

Source: RL (1998) as amended, Section H.9.g, ICD 19.

Discussion: Feed for the LAW contractor is delivered by transfer to the private contractor's feed tank; feed for the HLW contractor is delivered by transfer into a pipeline provided by that contractor.

A5.4 PHASE 1B WASTE TRANSFER DATE

This item is a:

	Constraint
	Requirement
X	Enabling Assumption
	Simplifying / Modeling Assumption

That applies to the:

X	HLW Staging Plan
X	LLW Staging Plan
X	Retrieval Sequence / Blending
	Process Flowsheet
X	OWVP
X	HTWOS
	DSS Inventory

Text of Item: The private contractor shall provide to the DOE contracting Officer a written request specifying the desired WTD 60 calendar days prior to the requested WTD. Within 30 calendar days of the written notice from the private contractor, the DOE Contracting Officer will issue a written response to the private contractor confirming that DOE will deliver a conforming batch of a specified volume to the private contractor on the WTD or such other date as DOE may propose. It will be assumed that the request and notification will be made in time that the facility will be able to continue operating at the normal processing rate.

Source: BNFL ICD 19, ICD 20.

A5.5 PHASE 1B FEED BATCH SAMPLES

This item is a:

	Constraint
X	Requirement
	Enabling Assumption
	Simplifying / Modeling Assumption

That applies to the:

X	HLW Staging Plan
X	LLW Staging Plan
	Retrieval Sequence / Blending
	Process Flowsheet
	OWVP
	HTWOS
	DSS Inventory

Text of Item: Samples of staged feed will be provided to the private contractor at least nine months (270 days) before delivery of feed. The samples will be delivered to the BNFL Inc. facility on the Hanford Site.

Source: ICD 19 and 20.

Discussion: The cited interface descriptions states that ORP will provide samples to the contractor for testing as part of the waste feed delivery process, if requested by the vendor. These samples are in addition to the samples required under Section C.5, Standard 2, Process Design Development, and under Section C.7, Interface Description 23.

A5.6 PHASE 1B FEED COMPOSITION INFORMATION

This item is a:

	Constraint
X	Requirement
	Enabling Assumption
	Simplifying / Modeling Assumption

That applies to the:

X	HLW Staging Plan
X	LLW Staging Plan
	Retrieval Sequence / Blending
	Process Flowsheet
	OWVP
	HTWOS
	DSS Inventory

Text of Item: The CHG will provide the composition of each feed batch to the private contractor at least 30 days prior to delivery to the private contractor as described in ICDs 19 and 20. The feed composition provided for the LAW will be the liquid composition only. The feed composition provided for the HLW will be both liquid and solid compositions.

A5.7 PHASE 1B WASTE FEED DELIVERY SEQUENCE

This item is a:

	Constraint
X	Requirement
	Enabling Assumption
	Simplifying / Modeling Assumption

That applies to the:

	HLW Staging Plan
X	LLW Staging Plan
X	Retrieval Sequence / Blending
X	Process Flowsheet
X	OWVP
X	HTWOS
	DSS Inventory

Text of Item: During minimum order quantity processing, DST supernate will be provided according to the following sequence (see Table A-11) and range of feed quantity:

Table A-11. Low-Activity Waste Feed Delivery Sequence.

Envelope	Units of LAW *
A	400-700
B	900-1700
C	500 - 1300
A	750 - 1200
C	500 - 1300
A	1400 - 3850

Table A-11. Low-Activity Waste Feed Delivery Sequence.

Envelope	Units of LAW *

*See section 5.1 for the definition of units of LAW for each feed type.

The tank-specific sequence for LAW feed delivery is given in Table A-12.

Table A-12. Phase 1 Low-Activity Waste Feed Delivery Tank Sequence.

Tank	Envelope
241-AP-101	A
241-AZ-101	B
241-AZ-102	B
241-AN-102	C
241-AN-104	A
241-AN-107	C
241-AN-105	A
241-SY-101	A
241-AN-103	A
241-AW-101	A
241-AW-104	A
241-SY-103	A
241-AP-106	A
241-S-102 (241-S-103, 241-S-105)	C
241-S-105 (241-S-106, 241-S-108)	C
241-AP-105	A
241-AP-108	A

The tank-specific sequence for delivery of HLW feed is given in Table A-13.

Table A-13. Phase 1 High-Level Waste Feed Delivery Tank Sequence.

241-AZ-101
241-AZ-102
241-AY-102 (241-C-106)
241-AY-101 (241-C-104)
241-SY-102
241-C-107/241-AW-103

Source: PIO (2000).

Discussion: LAW Envelope B feed is delivered as part of the waste in tanks 241-AZ-101 and 241-AZ-102. Tanks providing waste to meet the minimum order quantities in the BNFL contract are stated in the RPP Key Planning Assumptions (PIO 2000). Tanks in Tables A-12 and

A-14 listed after AW-101 and SY-102 for LAW and HLW, respectively, provide waste for the Extended Order through the end of the contract period.

A5.8 PHASE 1B MINIMUM FEED BATCH SIZE

This item is a:

	Constraint
X	Requirement
	Enabling Assumption
	Simplifying / Modeling Assumption

That applies to the:

X	HLW Staging Plan
X	LLW Staging Plan
X	Retrieval Sequence / Blending
X	Process Flowsheet
X	OWVP
X	HTWOS
	DSS Inventory

Text of Item: The initial LAW feed batch size will be between 400 and 700 units. Additional LAW feed batches will be at least 100 units. The minimum initial HLW feed batch size is 600 m^3 with an insoluble solids content of between 10 and 200 g/L. Additional batches will be at leaste 200 m^3 in volume including flush volumes.

Source: ICD 19 and ICD 20.

A5.9 PHASE 1B MODELED BATCH SIZES

This item is a:

	Constraint
	Requirement
X	Enabling Assumption
	Simplifying / Modeling Assumption

That applies to the:

	HLW Staging Plan
X	LLW Staging Plan
X	Retrieval Sequence / Blending
X	Process Flowsheet
X	OWVP
X	HTWOS
	DSS Inventory

Text of Item: CHG will deliver LAW feed to BNFL in 3,785 m^3 (1,000,000 gal) batches unless they are delivering the last part of the waste from a tank. These smaller transfers will be at least 946 m^3 (250,000 gal) in size. CHG will deliver HLW feed to BNFL Inc. in 600 m^3 batches unless they are delivering the last part of a batch group. These smaller transfers will be at least 200 m^3 in size.

Source: Personal communication with Russ Treat.

A5.10 PHASE 1B OUT OF SPECIFICATION FEED

This item is a:

	Constraint
X	Requirement
	Enabling Assumption
	Simplifying / Modeling Assumption

That applies to the:

	HLW Staging Plan
X	LLW Staging Plan
	Retrieval Sequence / Blending
	Process Flowsheet
	OWVP
	HTWOS
	DSS Inventory

Text of Item: The CHG will plan to deliver feed which meets the privatization contract specifications. If the feed does not meet the specifications, it will be processed under contract clause H.43. There are no plans to dilute or shim any out-of-specification feed.

Source: Derived from DOE-RL (1996) Mod. A012, (2000), Section C.6, Specifications 7 and 8.

Discussion: If the feed to the private contractor is out-of-specification, the private contractor will determine treatability of the waste. If the waste is treatable within the facility, a price for processing will be negotiated and the waste will be processed. (DOE [1996], Mod. A006 [1998] clause H.43). Contract compliance will be evaluated by the CHG in the source tank for direct transfers and in the intermediate waste feed staging tanks for staged waste.

A5.11 PHASE 1B LOW-ACTIVITY WASTE FEED SAMPLING STRATEGY--CONTRACTUAL

This item is a:

	Constraint
X	Requirement
	Enabling Assumption
	Simplifying / Modeling Assumption

That applies to the:

	HLW Staging Plan
X	LLW Staging Plan
	Retrieval Sequence / Blending
	Process Flowsheet
	OWVP
	HTWOS
	DSS Inventory

Text of Item: CHG will demonstrate the delivered waste meets the envelopes by sampling and analysis of the waste staged in the intermediate staging tanks.

Grab samples will be obtained from nine different depths from below a single riser. The total sample volume will meet the sample volume needs for analysis of the tank waste to support feed certification, provide a 1.5 L sample to the private contractor, and archive sample material.

The homogeneity of the soluble waste contents will be verified to determine the tank inventory. A tank waste will be composited and sub-sampled to be used for feed certification analysis. The arithmetic mean concentration for each analyte identified in Specification 7 will be determined from the analysis for the tree sub-sample results.

After confidence in the certification method is developed, the number of sample locations used in the tank may be decreased.

Source: Derived from ICD 19.

Discussion: The retrieved supernate may be of different composition than estimated due to projection uncertainties, source tank inhomogeneities or large amounts of entrained solids. If dilution water (or dilute caustic) is required for the retrieval/transfer of waste or to meet envelope limits, the composition may be further altered by dissolution or precipitation of solids. A similar concern exists for blending wastes to provide the proper batch sizes or using dilute waste as an alternative to water for dilution. Staging activities may further mix wastes from different source DSTs.

Issue: The precision and accuracy needed to satisfy *Resource Conservation and Recovery Act of 1976* (RCRA) requirements, and satisfy the private contractor's needs for feed composition data have not been determined.

A5.12 PHASE 1B FEED SAMPLING STRATEGY--REGULATORY

This item is a:

	Constraint
	Requirement
X	Enabling Assump tion
	Simplifying / Modeling Assumption

That applies to the:

	HLW Staging Plan
X	LLW Staging Plan
	Retrieval Sequence / Blending
	Process Flowsheet
	OWVP
	HTWOS
	DSS Inventory

Text of Item: Waste feed certification data obtained by the CHG will satisfy regulatory needs, or any additional sampling and analysis to satisfy regulatory needs can be completed within the same schedule window as certification sampling and analysis.

Source: Lerchen (1996) and Erlandson (1996), and ICD 19.

Discussion: The feed delivered to the private contractor is subject to RCRA regulations, however additional RCRA testing is not required prior to transfer to the private contractor. WAC 173-303-300 requires the operator to confirm his knowledge about a dangerous waste before his stores, treats, or disposes of it." This assumption bounds the duration for sampling and its impact on the feed delivery schedule.

Issue: The details on how regulatory requirements will be applied to the feed delivery transfer will be negotiated between RL, Washington State Department of Ecology (Ecology) and the private contractor during Part 1B. These will be documented in the private contractor's waste analysis plan. If regulatory sampling requires additional time beyond that needed for certification sampling, it will impact the feed delivery schedule.

A5.13 PHASE 1B MAXIMUM HIGH-LEVEL WASTE FEED BATCH VOLUME

This item is a:

	Constraint
X	Requirement
	Enabling Assumption
	Simplifying / Modeling Assumption

That applies to the:

X	HLW Staging Plan
	LLW Staging Plan
	Retrieval Sequence / Blending
	Process Flowsheet
	OWVP
X	HTWOS
	DSS Inventory

Text of Item: The maximum HLW feed batch volume will be 675 m^3 (178,000 gal) for the first feed batch, and 600 m^3 (159,000 gal) for subsequent batches..

Source: RL (1998) as amended and ICD 20.

Discussion: The initial HLW feed batch (including flush water) delivered to the private contractor will range in volume from 600 m^3 (159,000 gal) to 675 m^3 (178,000 gal). Subsequent batches of HLW feed will range in volume from 200 m^3 (52,800 gal) to 600 m^3 (159,000 gal).

A6.0 OPERATIONAL RATES, CAPACITIES, AND DURATIONS

A6.1 SIMULTANEOUS SINGLE-SHELL TANK RETRIEVALS PER QUADRANT

This item is a:

	Constraint
	Requirement
	Enabling Assumption
X	Simplifying / Modeling Assumption

That applies to the:

	HLW Staging Plan
	LLW Staging Plan
X	Retrieval Sequence / Blending
	Process Flowsheet
	OWVP
X	HTWOS
	DSS Inventory

Text of Item: SST retrieval operations will be limited to six simultaneous retrievals per tank farm, six simultaneous retrievals per quadrant, and seven simultaneous retrievals across all of the tank farms for the NE, NW and SW quadrants. SST waste retrieval operations in the SE quadrant will be limited to two simultaneous retrievals, with both of these allowable within the same tank farm.

Source: Kirkbride et al. (1999).

Discussion: The number of simultaneous retrievals that can occur per quadrant or tank farm is important because it affects blending and the overall retrieval rate. The number of simultaneous retrievals assumed above are based solely upon the planned capabilities of the DST system and WRFs (see section A6.2). Limitations on the number of simultaneous retrievals that can occur are due to the following.

- Physical space available in a tank farm for retrieval operations
- Operations staff available to operate retrieval equipment
- The transfer lines available to move retrieved waste
- The ability to detect leaks during retrieval. Simultaneous retrieval from multiple source tanks to a single destination tank may prevent adequate leak detection and mitigation.
- The cost for infrastructure to support more simultaneous retrievals.

Issue: The management Assessment performed during the first RTP effort (Honeyman 1998) and the MAR associated with it (Acree 1998) recommended that a maximum of five SSTs could be retrieved simultaneously, one each in the NE, SW, and SE quadrants and two in the NW quadrant. The assumption for the 2006 Hot Start scenario uses a higher number of simultaneous retrievals to be able to complete SST waste retrieval and processing by the year 2030 as directed by DOE-ORP (PIO 2000). A formal study should be performed to identify the specific drivers that will limit the number of simultaneous retrievals that can occur.

Source: Acree (1998), Honeyman (1998), PIO (2000).

A6.2 SIMULTANEOUS SINGLE-SHELL TANK RETRIEVALS INTO A SINGLE DOUBLE-SHELL TANK OR WASTE RECEIVER FACILITY TANK

This item is a:

	Constraint
	Requirement
X	Enabling Assumption
	Simplifying / Modeling Assumption

That applies to the:

	HLW Staging Plan
	LLW Staging Plan
X	Retrieval Sequence / Blending
	Process Flowsheet
	OWVP
X	HTWOS
	DSS Inventory

Text of Item: Up to two SSTs may be retrieved into one DST at a time. Only one SST may be retrieved into a WRF tank at one time.

Discussion: The maximum number of SSTs that can be simultaneously retrieved into a single DST or a single WRF tank has not been established. The number of SSTs that can be simultaneously retrieved into a single tank is an important factor in how the wastes are blended during retrieval, and it can also affect the overall retrieval rate.

Issue: A study should be performed to determine how many simultaneous retrievals into a single tank is reasonable.

A6.3 SINGLE-SHELL TANK RETRIEVAL RATE

This item is a:

	Constraint
	Requirement
X	Enabling Assumption
	Simplifying / Modeling Assumption

That applies to the:

	HLW Staging Plan
	LLW Staging Plan
X	Retrieval Sequence / Blending
	Process Flowsheet
	OWVP
X	HTWOS
	DSS Inventory

Text of Item: Salt cake and sludge will be retrieved from the SSTs at the rates listed below.

$R = 7.2\ m^3/day$ for $0.10\ \#(V_w/V_T)$
$R = 72 * (V_w/V_T)\ m^3/day$ for $0.10\ \$(V_w/V_T)\ \$\ 0.01$
$R = 0.72\ m^3/day$ for $0.01\ \$(V_w/V_T)$

<u>Where</u>
V_W = remaining volume of waste in tank
V_T = tank design volume

In HTWOS, SST retrieval operations continue until 0.4 m^3 (100 gallons) of waste is left in each SST.

The total retrieval time (in days) for each SST is calculated separately from the HTWOS model.

The "days to retrieve" are then used with the SST inventory in HTWOS (includes retrieval water) to calculate an average retrieval rate.

Source: Boomer et al. (1994); Orme (1994).

Issue: It is expected that retrieval will continue down to a minimum heel or until removal rate decreases below the turn-down ratio of the retrieval system. At this point in time, the heel would either be left in place (if acceptable for closure) or removed to support closure using different equipment. The endpoints (how clean is clean), timing (will closure activities begin immediately after retrieval), removal rate (how long will it take to remove the heels) and disposition of this material (will it be processed along with the rest of the waste) is not known.

A6.4 WASTE TRANSFER DURATIONS

This item is a:

	Constraint
	Requirement
	Enabling Assumption
X	Simplifying / Modeling Assumption

That applies to the:

X	HLW Staging Plan
X	LLW Staging Plan
X	Retrieval Sequence / Blending
	Process Flowsheet
	OWVP
X	HTWOS
	DSS Inventory

Text of Item: Transfer system setup times do not effect transfer durations and wastes are transferred at a rate of 763 m^3/day.

Source: Certa et al. (1996b), Table E-10 and Section 3.1; Galbraith et al. (1996).

Discussion: The *Low-Level Waste Feed Staging Plan* (Certa et al. 1996b) performed a Monte Carlo simulation of the performance of the transfer systems for both HLW and LAW feed staging. For purposes of preparing an operating scenario, a median value of 10 days was allocated for setup and transfer of waste batches. In order to simplify the HTWOS computer model, a decision was made to model all transfers at 763 m^3/day.

Many waste transfers of sizes significantly different from those used in the HLW and LLW feed staging plans are modeled for the retrieval sequence and blending work. The nominal 10 days combined duration does not apply. A transfer pump rate of 763 m^3/day will be used for all transfers. Transfer setup time will be neglected. The 763 m^3/day is the nominal transfer rate expected by the Transfer System Upgrades report.

Issue: An ongoing analysis has indicated that the transfer rates may be limited to 440 m^3/day (80 gal/min).

A6.5 CROSS-SITE TRANSFERS

This item is a:

	Constraint
	Requirement
X	Enabling Assumption
	Simplifying / Modeling Assumption

That applies to the:

	HLW Staging Plan
	LLW Staging Plan
X	Retrieval Sequence / Blending
	Process Flowsheet
	OWVP
X	HTWOS
	DSS Inventory

Text of Item: Prior to the sludge being removed from SY-102, the maximum volume that can be transferred cross-site is 2,740 m^3 (723,250 gal). After the sludge is removed the maximum volume that can be transferred cross-site is 3,990 m^3 (1,053,250 gal). For modeling convenience, a value of 2,840 m^3 (750,000 gal) has been chosen as a minimum transfer volume after the sludge has been removed from 241-SY-102. Less waste than the minimum identified here may be transferred under the following conditions: when long gaps are anticipated for waste received into 241-SY-102; when optimization of tank space can be achieved; and prior to tank 241-SY-102 closure.

Source: Discussions with M. J. Sutey; Payne (1998); and T0-430-506.

Discussion: There is no direction for the minimum volume to accumulate prior to making a cross-site transfer. It is preferable however, to retain as much waste as possible in 241-SY-102 prior to making a cross-site transfer. The maximum amount transferred prior to removing the sludge is equal to subtracting the volume required to be kept in the tank prior to removing the sludge and the buffer volume from the volume corresponding to the maximum operating height. The maximum amount transferred after the sludge has been removed is equal to subtracting the acceptable heel volume and the buffer volume from the volume corresponding to the maximum operating height. As a minimum volume after the 241-SY-102 sludge has been removed, a volume of 2,840 m^3 (750,000 gal) was assumed to minimize the number of transfers and the associated transfer flushes, while not requiring a DST to be completely filled prior to transfer.

Issue: Based on TRU waste not posing a compatibility concern, a study may be performed to lower the volume that must be kept in 241-SY-102 prior to removing the sludge.

Issue: Compatibility assessment results for waste transferred into 241-SY-102 may dictate transferring waste from tank 241-SY-102 without waiting for additional waste to accumulate in the tank.

Issue: All cross-site transfers must meet the requirements of the TWRS Authorization Basis. The requirements for the cross-site transfer line are identified in Addendum 2 of Noorani (1998a). Any transfers that fall outside of the basis will require revision of the authorization basis prior to the transfer being performed.

A6.6 SIMULTANEOUS TRANSFERS

This item is a:

	Constraint
	Requirement
X	Enabling Assumption
	Simplifying / Modeling Assumption

That applies to the:

	HLW Staging Plan
	LLW Staging Plan
X	Retrieval Sequence / Blending
	Process Flowsheet
	OWVP
X	HTWOS
	DSS Inventory

Text of Item: There is no limit on the total number of simultaneous transfers that can occur in the DST system. The transfer systems required to support these transfers are available when needed. The number of simultaneous transfers includes the transfers associated with retrieval of SST waste.

Discussion: During earlier retrieval sequence studies (Penwell 1996), it was determined that with a maximum of 16 possible simultaneous sluicing operations, there was a maximum of 46 lines in the tank farms transferring liquids at the same time (32 sluicing and 14 waste or chemical transfers). The feasibility of doing that, has not been evaluated.

Issue: There is significant risk in successfully performing the Phase 2 SST retrievals because the operations have not been planned in sufficient detail to know a practical limit for the number of simultaneous transfers.

A6.7 RETRIEVAL SYSTEM REUSE

This item is a:

	Constraint
	Requirement
X	Enabling Assumption
	Simplifying / Modeling Assumption

That applies to the:

	HLW Staging Plan
	LLW Staging Plan
X	Retrieval Sequence / Blending
	Process Flowsheet
	OWVP
X	HTWOS
	DSS Inventory

Text of Item: Retrieval systems will be reused. There will be one year between the time a retrieval system is taken out of service and when it can be reused in another tank. That time allows the system to be removed, decontaminated, serviced, and reinstalled in another tank.

Issue: No officially approved duration has been developed for the removal, decontamination, service, repair, and reinstallation of retrieval systems. Therefore, a one year duration period was used as a preliminary estimate.

A6.8 PHASE 1B FEED CERTIFICATION TIMING

This item is a:

	Constraint
	Requirement
	Enabling Assumption
X	Simplifying / Modeling Assumption

That applies to the:

	HLW Staging Plan
X	LLW Staging Plan
X	Retrieval Sequence / Blending
X	Process Flowsheet
	OWVP
X	HTWOS

				DSS Inventory

Text of Item: Mixing, settling, sampling, analysis, and compliance evaluation will take a total of 7 months per tank for LAW feeds and 9 months per batch group for HLW feeds.

Source: PIO 2000.

A6.9 PHASE 1B LAW FEED DELIVERY CONSTRAINTS

This item is a:

	Constraint
X	Requirement
	Enabling Assumption
	Simplifying / Modeling Assumption

That applies to the:

	HLW Staging Plan
X	LLW Staging Plan
X	Retrieval Sequence / Blending
X	Process Flowsheet
	OWVP
X	HTWOS
	DSS Inventory

Text of Item: The minimum time between feed batch transfers will be 30 days.

Discussion: The contract limits the minimum time between transfer of batches of LAW feed to 30 days/100 units of feed. The schedule of feed delivery is to be established as part of the ICD for ID 19 (Low-Activity Waste Feed).

Source: RL (1998) MOD. A012 (1998) and ICD 19.

A6.10 EVAPORATOR AVAILABILITY

This item is a:

	Constraint
	Requirement
X	Enabling Assumption
	Simplifying / Modeling Assumption

That applies to the:

X	HLW Staging Plan
X	LLW Staging Plan
X	Retrieval Sequence / Blending
	Process Flowsheet
X	OWVP
X	HTWOS
	DSS Inventory

Text of Item: The 242-A evaporator will be available, as needed, to support waste processing operations until the Phase 2 low-activity waste immobilization facilities become operational. There will an evaporator outage in FY 2004. During the outage Waste Management will complete all upgrades necessary (or provide alternative capabilities) to extend the operation to the end of Phase 1. The Phase 2 waste processing contractor(s) will provide evaporator capability for Phase 2.

Source: RPP Key Planning Assumptions (PIO 2000).

A6.11 EVAPORATOR OPERATION

This item is a:

	Constraint
	Requirement
X	Enabling Assumption
	Simplifying / Modeling Assumption

That applies to the:

X	HLW Staging Plan
X	LLW Staging Plan
X	Retrieval Sequence / Blending
	Process Flowsheet
X	OWVP
X	HTWOS
	DSS Inventory

Text of Item: The 242-A evaporator concentrates waste feeds to a specific gravity of 1.40 unless operation is limited by the condensate flow (upper limit of 50 gal/min). When operation is limited by the condensate flow, the waste is processed through the evaporator multiple times until the 1.4 specific gravity is reached. Evaporator campaigns will be scheduled eight months apart (from the end of one campaign to the start of the next campaign) when needed.

Issue: Concentration of some wastes to a specific gravity of 1.4 may result in solids precipitation. Actual operation of the evaporator depends upon the chemistry of the waste being concentrated.

A6.12 PHASE 2 NEW WASTE RECEIPTS

This item is a:

	Constraint
	Requirement
X	Enabling Assumption
	Simplifying / Modeling Assumption

That applies to the:

	HLW Staging Plan
	LLW Staging Plan
X	Retrieval Sequence / Blending
X	Process Flowsheet
X	OWVP
X	HTWOS
	DSS Inventory

Text of Item: Numerous waste transfers are anticipated from various sources into DSTs. Waste receipts that are specified on a yearly basis will be transferred to the DSTs at the beginning of the specified fiscal year unless more details are given explicitly in OWVP planning (Strode and Boyles 1999) or can be estimated from historical records (such as frequency of transfers per year). As a simplifying assumption, these transfers are modeled to occur at various intervals per year and to continue for an explicit time span in years. The list of waste generators and general transfer amounts is taken from the OWVP (Strode and Boyles 1999). Exceptions to the events planned in OWVP will be in the salt well pumping schedule, and the 241-SY-101 mitigation.

Source: Strode and Boyles (1999).

Discussion: During Phase 2, the OWVP (Strode and Boyles 1999) quantifies the waste receipts into the DSTs from various facilities and sources and projects DST space to a resolution of one year. Since timing of transfers is important for the HTWOS model, higher resolution is needed to specify the time that the new waste receipts are introduced to the DSTs. Frequency of transfers and the tanks receiving the waste are determined for modeling purposes from past practice and the waste type being transferred. The beginning of the specified fiscal year will be assumed if no other data are available.

A6.13 PHASE 1 IMMOBILIZED LOW-ACTIVITY WASTE PACKAGE PRODUCTION RATE

This item is a:

	Constraint
	Requirement
	Enabling Assumption
X	Simplifying / Modeling Assumption

That applies to the:

	HLW Staging Plan
	LLW Staging Plan
	Retrieval Sequence / Blending
	Process Flowsheet
	OWVP
X	HTWOS
	DSS Inventory

Text of Item: The private contractor will produce and deliver ILAW packages at a batch-average rate during the Phase 1 mission. The batch-average ILAW production rates will be based upon the planned Phase 1 waste feed delivery and processing schedules for each batch and on ILAW waste loading (see Section A7.19).

BNFL Inc. has estimated that they will produce, on average, 2.38 ILAW packages every day. At the maximum production rate, approximately 4 ILAW packages will be produced every day. BNFL Inc. will store the ILAW packages in lag storage until accepted by DOE.

Delivery of the packages from the private contractors LAW immobilization plants and receipt at the RPP Disposal Facility will be calculated separately from the HTWOS model. The BNFL Inc. in-plant storage capacity for ILAW packages in Phase 1 is 450. It is assumed that BNFL Inc. will operate the storage area at 50% of capacity. ILAW delivery dates are based on the HTWOS estimated production date plus the delay necessary to maintain 225 ILAW packages in BNFL Inc. in-plant storage. For Phase 2 the in-plant storage capacity is assumed to be increased to 1,800 ILAW packages. This increase is proportional to the nominal production rates of the Phase 1 and Phase 2 LAW vitrification facilities.

Source: Personal communication with Kayle Boomer on February 7, 2000, and personal communication with Stuart MacKay on January 17, 2000.

Discussion: ILAW package production rates have been estimated and time and motion studies of package delivery and transfer into storage were performed as part of the TWRS ILAW Disposal Facility design. The timing of ILAW package production is being modeled in HTWOS to provide a flowsheet-based production estimate.

Issue: Shipping schedules from the private contractor will be needed to model the production and delivery of ILAW packages if that degree of accuracy is required.

A6.14 PHASE 1 HIGH-LEVEL WASTE CANISTER PRODUCTION

This item is a:

	Constraint
	Requirement

That applies to the:

	HLW Staging Plan
	LLW Staging Plan

	Enabling Assumption
X	Simplifying / Modeling Assumption

	Retrieval Sequence / Blending
	Process Flowsheet
	OWVP
X	HTWOS
	DSS Inventory

Text of Item: BNFL Inc. will produce and deliver immobilized high-level waste (IHLW) canisters at a batch-average rate during the Phase 1 mission. The batch-average IHLW canister production rate will be based upon the planned Phase 1 waste feed delivery and processing schedules for each batch and contractual limits on IHLW loading (see Section A7.13).

BNFL Inc. has estimated that they will produce, on average, approximately one 4.5-m long by 0.61-m diameter IHLW canister every 3 - 4 days. At the maximum production rate, approximately 1 canister will be produced every 2 days. BNFL Inc. will store the IHLW canisters in lag storage until accepted by DOE.

Delivery of the canisters from the private contractor's HLW immobilization plant and receipt at the RPP Canister Storage Building (CSB) will be calculated separately from the HTWOS model. The BNFL Inc. in-plant storage capacity for IHLW canisters in Phase 1 is 45. It is assumed the BNFL Inc. will operate the storage area at 50% of capacity. ILAW delivery dates are based on the HTWOS estimated production date plus the delay necessary to maintain 23 IHLW canisters in BNFL Inc. in-plant storage. For Phase 2 the in-plant storage capacity is assumed to be increased to 175 IHLW packages. This increase is proportional to the nominal production rates of the Phase 1 and Phase 2 HLW vitrification facilities.

Source: Personal communication with Kayle Boomer on February 7, 2000, and personal communication with Stuart MacKay on January 17, 2000.

Discussion: The maximum canister handling capacity of the TWRS CSB was estimated at 1.35 canisters per day. The canister handling rate was determined by considering the timing of the package transporter from the privatization facilities to the IHLW Storage Facility, as well as the operation of the unloading system and facility cranes and control systems installed in the modified CSB. A flowsheet-based IHLW canister production rate is being estimated to verify the Project W-464 handling capacity estimates.

Issue: Shipping schedules from the private contractor will be needed to model the production and delivery of IHLW canisters if that degree of accuracy is required.

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A7.0 PROCESS CALCULATIONS

A7.1 DENSITY CALCULATIONS

This item is a:

	Constraint
	Requirement
	Enabling Assumption
X	Simplifying / Modeling Assumption

That applies to the:

X	HLW Staging Plan
X	LLW Staging Plan
X	Retrieval Sequence / Blending
X	Process Flowsheet
X	OWVP
X	HTWOS
	DSS Inventory

Text of Item: A linear estimation will be used for liquid density. The equation is:

$$\boldsymbol{r} = a_0 + \sum_{i=1}^{n} a_i C_i$$

Where, a_o is the water density, a_i are component specific constants and C_i are concentrations in moles/liter. Values for a_i are tabulated in Appendix I.

Discussion: This density estimation technique ignores the fact that partial molar volumes of components are a function of concentration. Nevertheless, experience has shown that the calculated density is reasonably accurate over a wide range of concentration. Revising the constants is straightforward when warranted by new data. Constants for additional components can be added easily.

Issue: The principle shortcoming of this method is that higher-than-possible liquid phase densities can be calculated because the method does not recognize when solubility is exceeded. Unrealistic liquid phase density (typically >1.5 kg/m^3) should be regarded skeptically.

A7.2 TRANSURANIC CALCULATIONS

This item is a:

	Constraint
	Requirement
X	Enabling Assumption
	Simplifying / Modeling Assumption

That applies to the:

X	HLW Staging Plan
X	LLW Staging Plan
X	Retrieval Sequence / Blending
X	Process Flowsheet
	OWVP
X	HTWOS
X	DSS Inventory

Text of Item: Determination of transuranic content is performed by summing the contributions of the following radionuclides: ^{237}Np, ^{238}Pu, ^{239}Pu, ^{240}Pu, ^{241}Pu, ^{242}Pu, ^{244}Pu, ^{241}Am, ^{243}Am, ^{243}Cm, ^{244}Cm, ^{245}Cm, ^{246}Cm, ^{248}Cm.

Discussion: Specification 2 invokes radionuclide limits for Class C as defined in 10 CFR 61.55 and NRC's *Branch Technical Position* (NRC 1991): alpha-emitting transuranics with >5 year half-life shall be less than 100 nCi/g in the glass waste form.

Source: RL (1998).

Issue: It can be shown that several of these nuclides will never be present in an amount significant enough to affect waste classification and some are not present in the current BBI. Specification 2 of the contract could be revised to eliminate inconsequential radiological contributors (probably ^{244}Pu, ^{245}Cm, ^{246}Cm, ^{248}Cm).

Issue: DOE Order 435.1 defines TRU as a waste containing alpha-emitting isotopes having half-lives greater than 20 years. The contract relates the term TRU to 10 CFR 61.55. 10 CFR 61.55 does not use the term TRU, but identifies alpha-emitting isotopes having half-lives greater than 5 years as the basis for determining waste class. The DOE definition of TRU should be retained and another term used for the calculation done in accordance with 10 CFR 61.55.

Issue: Inclusion of ^{241}Pu in the calc is in question because ^{241}Pu is listed separately in Table 1 of 10 CFR 61.55. For the time being, inclusion of ^{241}Pu gives conservative results.

A7.3 RADIONUCLIDE DECAY CALCULATIONS

This item is a:

	Constraint
	Requirement
	Enabling Assumption
X	Simplifying / Modeling Assumption

That applies to the:

X	HLW Staging Plan
X	LLW Staging Plan
X	Retrieval Sequence / Blending
X	Process Flowsheet
	OWVP
X	HTWOS
	DSS Inventory

Text of Item: All time dependent analysis (feed staging and retrieval sequence and blending strategy and HTWOS) will decay radionuclide inventories over time. Equilibrium daughter products and ingrowth will not be tracked.

Discussion: For internal calculations, all input and internal inventories and streams will be decayed to a uniform decay date of January 1, 1994. All inventories and streams will then be decayed to the time of output or examination per Section 7.4. The 1994 date was selected to match the decay date of the best-basis inventory.

A7.4 DECAY DATES FOR ENVELOPE ASSESSMENTS

This item is a:

	Constraint
	Requirement
	Enabling Assumption
X	Simplifying / Modeling Assumption

That applies to the:

X	HLW Staging Plan
X	LLW Staging Plan
	Retrieval Sequence / Blending
	Process Flowsheet
	OWVP
	HTWOS
	DSS Inventory

Text of Item: For planning purposes, the nominal decay date for radionuclides for envelope assessment and tank classification will be December 31, 2007. For evaluating contract compliance and HTWOS modeling purposes, radionuclides will be decayed to the feed delivery date.

Discussion: For internal calculations, all input and internal inventories and streams will be decayed to a uniform decay date of January 1, 1994. The nominal decay date for radionuclides of December 31, 2007, is a conservative decay date for planning purposes.

Source: RL (1998) MOD. A012 Specifications 7 and 8.

A7.5 HEEL COMPOSITION

This item is a:

	Constraint
	Requirement
	Enabling Assumption
X	Simplifying / Modeling Assumption

That applies to the:

	HLW Staging Plan
X	LLW Staging Plan
X	Retrieval Sequence / Blending
	Process Flowsheet
X	OWVP
X	HTWOS
X	DSS Inventory

Text of Item: The liquid and/or solid heels remaining in DSTs are assumed to have the composition of the corresponding phase last present in that tank.

A7.6 TRANSFER LINE FLUSHES

This item is a:

	Constraint
	Requirement
	Enabling Assumption
X	Simplifying / Modeling Assumption

That applies to the:

X	HLW Staging Plan
X	LLW Staging Plan
X	Retrieval Sequence / Blending
X	Process Flowsheet
X	OWVP
X	HTWOS
	DSS Inventory

Text of Item: Transfers between BNFL, Inc. and DOE are always followed by a flush of water adjusted to 0.01*M* NaOH and 0.011*M* $NaNO_2$. The flush is initiated by the party making the transfer. Table A-14 summarizes how HTWOS currently accounts for flushes. Note that SST to DST flushes are proportional to volume. HTWOS does not currently flush from DSTs to BNFL Inc.

Table A-14. Waste Transfer Flush Volumes.

Transfer type	Flush volume in gal
Cross-site	24,000
Northwest Quadrant WRF to West area cross-site transfer tank	6,000
Northeast Quadrant WRF to Receiving tank	7,500
U Farm WRF to West area cross-site transfer tank	500
East Area DST to DST or DST to LAW feed staging tank transfer	500
From SST to BNFL (SWL)	Variable
DST to BNFL	Currently zero

Source: Phase 2 volumes are generic estimates for area to area transfers in Memorandum from C. E. Grenard to D. L. Penwell dated January 21, 1997.

Discussion: Phase 1 transfers are based on the rule of thumb that slurries require two line volumes and liquids require one line volume. LAW feed from DOE is flushed with a single line volume (ICD-19 allows up to three line volumes). HLW feed from DOE is flushed with two line volumes (ICD-20 allows up to three line volumes). Line flushes are modeled to approximate the impact on space requirements.

The volume of typical transfer line flushes for Phase 1B is shown in Table A-15.

Table A-15. Phase 1 Waste Transfer Flush Volumes.

Transfer type	Flush volume
From 241-AZ-101 to BNFL, Inc. (1.9 m^3 drains back to 241-AZ-101)	13.7 m^3 (3620 gal)
From 241-AZ-102 to BNFL, Inc. (2.1 m^3 drains back to 241-AZ-102)	14.2 m^3 (3750 gal)
From 241-AN-102 to 241-AP-104*	2.82 m^3 (750 gal)
From 241-AN-103 to 241-AP-104*	2.78 m^3 (730 gal)
From 241-AN-104 to 241-AP-104*	2.29 m^3 (600 gal)
From 241-AN-105 to 241-AP-104*	2.77 m^3 (730 gal)
From 241-AN-107 to 241-AP-104*	2.92 m^3 (770 gal)

*For the LAW transfers from source tanks to 241-AP-104 it is assumed the most direct routing that is available, one line volume of flush, and it all drains back to the source tank.

The sources of information for the Phase 1 assumption are ICD-16, ICD-19, and ICD-20. Actual Phase 1 volumes were calculated from pipeline dimensions by R. Orme.

Discussion: The volume of available tank space will be affected by the line flushes, therefore their effect will be estimated.

Note: The OWVP (Strode and Boyles 1999) and HTWOS account for line flushing differently.

Flushing in the OWVP (Strode and Boyles 1999) is handled in a variety of ways. The only flush with a fixed volume is after a cross-site transfer. New waste from facilities is flushed with a percentage of the waste volume. Day-to-day intertank transfers are flushed with a generic monthly volume that covers all the transfers for the month. There are generic flush volumes associated with evaporator operations.

As discussed above, flushing in the HTWOS model is with a fixed volume after each pipeline transfer (except after SST to DST transfer). This gives an estimate that is based upon the estimated number of transfers, rather than a more generic guess at what is needed per month to cover flushes for transfers. The total flush volumes for the two methods should be in the same general volume range.

A7.7 PHASE 1B LOW-ACTIVITY WASTE MASS-BALANCE AND SOLID-LIQUID EQUILIBRIA CALCULATIONS

This item is a:

	Constraint
	Requirement
X	Enabling Assumption
	Simplifying / Modeling Assumption

That applies to the:

	HLW Staging Plan
X	LLW Staging Plan
	Retrieval Sequence / Blending
X	Process Flowsheet
	OWVP
	HTWOS
	DSS Inventory

Text of Item: During retrieval and staging of LAW feed during Phase 1B, the following methodology will be used:

1. Solid-Liquid equilibria will be ignored when mixing waste with other waste, i.e., mixing waste does not induce precipitation.

2. Before transfer, retrieved waste will be diluted to 7*M* [Na] so that the bulk composition is below saturation in major sodium salts and so its bulk SpG satisfies the rule in Section A3.2.

3. Additions of NaOH and $NaNO_2$ to meet tank composition requirements of Tank Farm Operating Specification OSD-T-151-00007 are modeled in HTWOS only for two tanks that are known to be out of specification, 241-AN-102 and 241-AN-107.

Discussion: The solubility of Al is a function of $[OH^-]$ and total ionic strength. For the Al-Na-OH-H_2O system, maximum Al solubility occurs when $[OH^-]$ is about 6*M*. When other sodium salts are present at maximum ionic strength, as in tank waste, maximum Al solubility occurs at about 2*M* OH^-. Dilution of aluminum containing solutions with water may precipitate gibbsite.

Source: Barney (1976).

Discussion: When two samples of waste from tank 241-AW-101 were diluted 1:1 (water:waste) about 95 percent of the strontium precipitated. This is an example of solid-liquid equilibria of a minor component that violates the above "no precipitation" rule.

Source: Bray (1989).

Discussion: Under some circumstances, changing the pH of a retrieved waste can cause precipitation. Also, under some circumstances, mixing two wastes of different composition can cause precipitation. Low solubility double salts are responsible for the phenomenon. The HTWOS model currently lacks the capability to identify situations where there is a potential for precipitation.

Source: Ron Orme.

Discussion: Specification 7 requires all feed to meet Tank Farm Operating Specification OSD-T-151-00007, however, an exception is granted for free hydroxide. The tank composition specification contains terms for $[OH^-]$, $[NO_2^-]$, and $[OH^-]+[NO_2^-]$, so if $[OH^-]$ is exempted, only additions of NO_2^- would be required to meet specification. The in-growth of NO_2^- in most tanks is more than sufficient to cover the requirement.

Issue: ORP and BNFL Inc. negotiated Specification 7, but it isn't clear that CHG Technical Operations has agreed. TO may be expected by Ecology to observe all the terms of the operating specification.

Discussion: A better understanding of solid-liquid equilibria in this waste is needed. Estimating the quantity of solids that precipitate during staging activities is beyond the capability of the HTWOS model. This may also influence dilution water requirements (perhaps by requiring the ability to add caustic) and the disposition of the solids. Understanding the physical properties of the diluted waste is important to proper transfer system design and operation as is understanding the dissolution kinetics.

Lacking an integrated method of estimating solid-liquid equilibria, HTWOS cannot deal with the following in a rigorous manner:

> Estimation of the dissolution of solids in the slurries or entrained in otherwise clear supernate as a function of dilution water.

Estimation of the precipitation of solids due to dilution during retrieval or due to in-line dilution during transfer.

Estimation of the degree of saturation of the major waste components as a function of dilution.

Estimation of the quantity of solids in the waste as-transferred and resultant physical properties such as SpG and viscosity.

Estimation of the quantity and composition of solids accumulating in the intermediate feed staging tank.

Estimation of the composition of the supernate in the intermediate feed staging tank to verify that envelope compliance has not been compromised due to solid-liquid equilibria.

A7.8 ENTRAINED SOLIDS--COMPOSITION

This item is a:

	Constraint
	Requirement
	Enabling Assumption
X	Simplifying / Modeling Assumption

That applies to the:

X	HLW Staging Plan
X	LLW Staging Plan
X	Retrieval Sequence / Blending
X	Process Flowsheet
X	OWVP
X	HTWOS
X	DSS Inventory

Text of Item: The composition of entrained solids is similar to the settled solids prior to the transfers.

Issue: Actual entrained solids are more than likely a different sort of material from settled solids – otherwise they would have settled. Characterization of entrained solids is difficult because we only deal with samples that have been disturbed, fluffed up, etc.

A7.9 ENTRAINED SOLIDS--QUANTITY ENTRAINED

This item is a:

	Constraint
	Requirement
X	Enabling Assumption
	Simplifying / Modeling Assumption

That applies to the:

	HLW Staging Plan
X	LLW Staging Plan
X	Retrieval Sequence / Blending
X	Process Flowsheet
X	OWVP
X	HTWOS
	DSS Inventory

Text of Item: Supernates decanted from LAW tanks contain 0.5 wt% solid phase. LAW supernate obtained after dissolving salts will contain up to 2 wt% solid phase.

Discussion: The Phase 1B contract limit for entrained solids is 2 wt%. However, the original entrainment basis (Geeting 1995) for supernates indicates 0.1 to 0.8 wt% which has been nominalized at 0.5 wt% (Orme 1998). The salt sludge will be vigorously mobilized during dissolution, so the contract maximum seems appropriate for sludge dissolate transfers. To visualize what a 2 wt% slurry would be like, consider that the 241-AZ-101 slurry transfer is only about 4 wt% solids, so 2 wt% is a very conservative amount of entrainment that should not be at all difficult to achieve by gravity settling.

BNFL's LAW receiving tanks are designed to receive "non-settling" solids. They do not have the capability to resuspend high density particles.

During Phase 2, all retrieved waste is routed to the out-of-tank sludge washing system as slurry, so the Entrained Solids assumption is irrelevant to Phase 2.

Issue: Experimental dissolutions to predict residual solids may be misleading if the sample is not precisely representative of the sludge in the tank.

Source: Geeting (1995), Orme (1998).

A7.10 WASTE RETRIEVAL AND TRANSFER CONDITIONS

This item is a:

	Constraint
	Requirement
	Enabling Assumption
X	Simplifying / Modeling Assumption

That applies to the:

	HLW Staging Plan
	LLW Staging Plan
X	Retrieval Sequence / Blending
	Process Flowsheet
	OWVP
X	HTWOS
	DSS Inventory

Text of Item: The retrieval and transfer conditions for Phase 2 are given in Table A-16. Phase 1 feeds will be diluted sufficiently to transfer to BNFL Inc. within transfer system constraints. Specifics for each tank will be discussed in Volume I, Chapters 3.0 and 4.0.

Table A-16. Waste Retrieval and Transfer Assumptions.

Parameter	Value	Comment
Maximum wt% solids in Transfer Solution	10 wt% based upon the liquid density	The specific gravity of dry solids is assumed to be 3.0
Maximum Supernatant Na molarity during waste transfers	5*M*	

The values given in this table are based upon available test data and upon current restrictions associated with transfers.

A7.11 SLUDGE WASH PROCESS

This item is a:

	Constraint
	Requirement
X	Enabling Assumption
	Simplifying / Modeling Assumption

That applies to the:

X	HLW Staging Plan
	LLW Staging Plan
X	Retrieval Sequence / Blending
X	Process Flowsheet
	OWVP
X	HTWOS
	DSS Inventory

Text of Item: Water washing is the assumed pretreatment process for sludge from tanks 241-AZ-101 and 241-AZ-102. Caustic leaching is the assumed sludge wash process for waste from all remaining tanks. No sludge washing occurs in conjunction with feed delivery. HTWOS will establish the initial solid-liquid splits in DSTs and that which occurs in conjunction with retrieving SSTs (i.e., establishing the solid-liquid splits in sluiced sludges). All leaching and washing of HLW solids now occurs in BNFL Inc. facilities. For modeling purposes, sludge washing at BNFL Inc. is assumed to occur at 27.5 wt% solids concentration.

The Phase 2 contractors will utilize their own facilities for out-of-tank (i.e., out of the 28 DSTs) sludge washing to pretreat sludge. For modeling purposes, the out-of-tank sludge wash process will be close coupled to the LAW glass plant. It is modeled as an instantaneous operation so that it is not the rate-limiting step. Out-of-tank sludge washing is assumed to occur at 27.5 wt% solids concentration.

Source: Slaathaug et al. (1996).

A7.12 SLUDGE WASH FACTORS

This item is a:

	Constraint
	Requirement
X	Enabling Assumption
	Simplifying / Modeling Assumption

That applies to the:

X	HLW Staging Plan
	LLW Staging Plan
X	Retrieval Sequence / Blending
X	Process Flowsheet
	OWVP
X	HTWOS
	DSS Inventory

Text of Item: Tank specific wash and leach factors for use with the BBI are available in *Best Basis Wash and Leach Factor Analysis* (Hendrickson et al. 1999).

Discussion: The *Best Basis Wash and Leach Factor Analysis* (Hendrickson et al. 1999) culminates a year-long effort to digest all available leach and wash data, and to supplement lab data with chemical modeling results where data are absent. Factors for each of the 177 tanks were developed. Tank specific leach factors are used for waste from Phase 1 HLW tanks only. Phase 2 uses global leach factors.

A7.13 PHASE 1B AND 2 IMMOBILIZED HIGH-LEVEL WASTE COMPOSITION AND VOLUME

This item is a:

	Constraint
	Requirement
X	Enabling Assumption
	Simplifying / Modeling Assumption

That applies to the:

X	HLW Staging Plan
	LLW Staging Plan
X	Retrieval Sequence / Blending
X	Process Flowsheet
	OWVP
X	HTWOS
	DSS Inventory

Text of Item: The method for estimating HLW glass will be the same for both Phase 1 and Phase 2. Two estimates of HLW glass volume and composition will be made. These estimates can roughly be considered as bounding.

The estimates are as follows:

1. A volume and composition based on the maximum waste oxide loading determined within the glass property model constraints.

2. A maximized volume based on Component Limits from Specification 1, Table TS-1.1 of the TWRS Privatization Contract.

Source: RL (1998) MOD. A006 (1998), as amended.

Discussion: The FY 2000 MYWP Update Guidance states that the glass properties model is to be used for estimating the amount of glass for both Phase 1 and Phase 2. The planning for retrieval and feed staging should be based upon an estimate of the minimum amount of glass that may be produced and takes the least amount of time to process. Maximizing the waste oxide loading in the glass through use of the glass property model provides that estimate. The BNFL contract limits result in an estimate of the maximum amount of glass that may be produced, and takes the longest time to process. This estimate is the proper estimate to use for planning associated with the amount of immobilized storage needed.

Text of Item: The maximum glass volume that BNFL Inc. may produce is determined by the minimum component limits in Table TS-1.1 when only one component (or sum of components) concentration exceeds the tabulated value. The volume is calculated based upon a glass density of 2.66 MT/m^3. In addition to being able to estimate the maximum volume of glass using the minimum component limits in Table TS-1.1, the maximum volume of glass will result in the slowest possible retrieval and feed staging estimates. Therefore, the timing estimates based upon those numbers should not be used to determine project schedules for feed staging and retrieval.

Source: RL (1998), as amended, Section C, Specification 1.

Text of Item: For determining the fastest HLW feed scenario, the volume and composition of immobilized HLW will be estimated by minimizing the amount of material added to the feed subject to the following property models: (a) Liquidus temperature model for spinel, second order model, (b) Liquidus temperature model for zirconia, first order model, (c) model for nepheline, (d) Fulcher first-order viscosity model, and (e) second order model for 7-day Product Consistency Test (PCT) for Li, Si, Na and B. In addition, each component must be within the range of validity for the above property models as listed in Table A-17. The assumed melter temperature, T, will be 1,150 EC.

Table A-17. High-Level Waste Glass Composition Limits For the Glass Properties Model.

Component	Minimum, wt%	Maximum, wt%
SiO_2	42.0	57.0
B_2O_3	5.0	20.0
Al_2O_3	0.	17.0
Fe_2O_3	0.5	15.0
ZrO_2	0.	13.0
Na_2O	5.0	20.0
Li_2O	1.0	7.0
CaO	0.	10.0
MgO	0.	8.0
Cr_2O_3	0.	0.5
P_2O_5	0.	3.0
Other	1.0	10.0

Table A-18. High-Level Waste Glass Property Limits.

Property	Units	Minimum	Maximum
Viscosity @ T=1150EC	Pa·S	4.5	5.5
Liquidus Temperature	EC	-none-	T-100
Nepheline	Normalized SiO_2	0.62	-none-
Durability	g/m^2 over 7-day PCT interval	-none-	2.0

Source: Lambert et al. (1996) and Elliott (1996).

$$T_L(°C) = \sum_i a_i \quad x_i$$

(a) **FIRST ORDER LIQUIDUS TEMPERATURE MODEL FOR SPINEL**

Where a_i = first order coefficient for component I

x_i = mass fraction of component I

x_j = mass fraction of component j

T_l = liquidus temperature in degrees Celsius (T-100)

Table A-19. Second Order Spinel Liquidus Temperature Model Estimated Coefficients. (Hrma 1999) (2 Sheets)

Coefficient identifier for equation	component	Estimated coefficient value $R^2 = 0.93$
A	SiO_2	1010.0
A	B_2O_3	403.0
A	Na_2O	-1736.0
A	Li_2O	-1367.0
A	CaO	1757.0
A	MgO	3820.0
A	Fe_2O_3	2685.0
A	Al_2O_3	2866.0
A	K_2O	-980.0
A	Cr_2O_3	20592.0
A	MnO	1312.0
A	NiO	9530.0
A	Others	3583.0
A	TiO_2	4925.0
A	U_3O_8	1633.0

$$T_L(°C) = \sum_i b_i \quad x_i$$

(b) **FIRST ORDER LIQUIDUS TEMPERATURE MODEL FOR ZIRCONIA**

Where X_i = mass fraction of component I

b_i = coefficient for component I
T_l = liquidus temperature in degrees Celsius (T-100)

Table A-20. First Order Liquidus Temperature Model for Zirconia Estimated Coefficients.

Component	Estimated Coefficient R^2 = 0.79
SiO_2	753.78
B_2O_3	1095.83
Al_2O_3	1138.06
Fe_2O_3	1461.04
ZrO_2	4541.99
Na_2O	74.31
Li_2O	-956.39
CaO	886.76
MgO	2458.47
Others	657.99

(c) NEPHELINE LIMIT EQUATION

The key to avoiding the nepheline region is to maintain a normalized SiO_2 content $\geq$ 0.62 as given below.

$$\text{Nepheline Limit} = \frac{SiO_2}{SiO_2 + Al_2O_3 + Na_2O} \geq 0.62$$

(d) VISCOSITY EQUATION

The Fulcher equation as given below is used to determine the liquid glass viscosity.

$$\text{In}\ \eta = \text{sum}\ (A_{Fi}X_i) + \text{sum}\ (B_{Fi}X_i)/[T - \text{sum}\ (T_iX_i)]\ (\text{T in EC}),$$

where X_i represents the oxide mass fraction of each component and A_{Fi} and B_{Fi} and T_i are the model coefficients (R^2 = 0.9958). The R^2 terms are a measure of the statistical fit, with R^2 = 1.0 representing a perfect fit of the statistical model to the experimental data.

Table A-21. Viscosity Model Coefficients.

Fulcher First-Order Viscosity Model Coefficients A, B, and T_i.		
Variable	Coefficient	Coefficient Estimate
SiO_2	A	-10.5899
B_2O_3	A	-24.4127
Al_2O_3	A	1.4998

Table A-21. Viscosity Model Coefficients.

Fulcher First-Order Viscosity Model Coefficients A, B, and T_i.		
Variable	Coefficient	Coefficient Estimate
Fe_2O_3	A	-13.6326
ZrO_2	A	-0.3590
Na_2O	A	2.02
Li_2O	A	5.4558
CaO	A	3.9535
MgO	A	5.3088
Others	A	-2.3815
SiO_2	B	19236.3263
B_2O_3	B	15922.8410
Al_2O_3	B	9524.4388
Fe_2O_3	B	14599.3344
ZrO_2	B	4618.1457
Na_2O	B	-12965.4177
Li_2O	B	-39177.2042
CaO	B	-18671.4525
MgO	B	-11943.9611
Others	B	1710.2061
SiO_2	T_1	76.1127
B_2O_3	T_2	263.4849
Al_2O_3	T_3	178.5252
Fe_2O_3	T_4	43.6384
ZrO_2	T_5	540.5086
Na_2O	T_6	425.7163
Li_2O	T_7	474.4299
CaO	T_8	1065.8248
MgO	T_9	752.2421
Others	T_{10}	270.7406

(e) DURABILITY EQUATION

The durability of borosilicate glass is the property defining radionuclide release from the waste form. The intrusion of groundwater into and through a geologic repository is the most likely mechanism for transporting radionuclides into the biosphere. Thus, it is important that nuclear waste glasses be stable in the presence of groundwater over the geologic time scale. The durability can be estimated using the equation below.

$$\ln r_i = \text{sum}\,(a_j X_j) + \text{sum}\,(c_{ij} X_i X_j)]$$

where: r_i is the mass release of element i (g/m^2)
X_i represents the oxide mass fraction of each component
a_j is the single component coefficient
c_{ij} is the mixed component coefficient

The coefficients for the equation are based upon a 7-day PCT. The equation is calculated for silicon, lithium, boron, and sodium.

Table A-22. Coefficients for Second Order Model of Natural Logarithm of Average 7-Day Product Consistency Test Normalized Elemental Releases (g/m^3). (2 Sheets)

Coefficient	Component(s)	PCT-silicon	PCT-boron	PCT-lithium	PCT-sodium
a_j	SiO2	-2.3415	-4.1267	-3.3159	-1.7652
a_j	B2O3	2.2959	-2.7803	12.4446	-10.4721
a_j	Al2O3	-28.9796	-39.6897	-37.6244	-32.6424
a_j	Fe2O3	-5.6296	-0.7342	-5.5866	-2.8512
a_j	ZrO2	-17.2431	-21.8129	-10.3597	16.1412
a_j	Na2O	17.8263	19.7648	16.385	12.5007
a_j	Li2O	18.0258	25.1279	16.9458	7.5967
a_j	CaO	11.2689	7.8944	20.5631	8.5246
a_j	MgO	-1.7491	-51.2479	12.1879	-17.0361
a_j	Others	-2.5487	4.3558	-19.0889	0.7069
c_{ij}	Al2O3-Al2O3	96.5647	105.2815	99.7873	89.9973
c_{ij}	SiO2-MgO	0	119.5209	0	57.6768
c_{ij}	Na2O-ZrO2	0	70.4225	0	0
c_{ij}	CaO-ZrO2	95.2066	101.8736	0	0
c_{ij}	B2O3-CaO	0	-80.9291	-119.825	-96.6209
c_{ij}	Na2O-CaO	0	-90.8996	-120.702	0
c_{ij}	MgO-ZrO2	109.7168	146.706	0	0
c_{ij}	Na2O-Al2O3	-53.2773	0	0	0
c_{ij}	B2O3-Na2O	-40.6487	0	0	0
c_{ij}	SiO2-CaO	-43.2976	0	0	0
c_{ij}	Li2O-MgO	0	0	165.687	0
c_{ij}	MgO-Al2O3	0	0	-153.562	0
c_{ij}	Fe2O3-Al2O3	0	0	82.5595	0
c_{ij}	Na2O-Li2O	0	0	0	152.3524
c_{ij}	SiO2-ZrO2	0	0	0	-53.2743

Table A-22. Coefficients for Second Order Model of Natural Logarithm of Average 7-Day Product Consistency Test Normalized Elemental Releases (g/m^3). (2 Sheets)

Coefficient	Component(s)	PCT-silicon	PCT-boron	PCT-lithium	PCT-sodium
c_{ij}	Li2O-Al2O3	0	0	0	-86.3851
c_{ij}	B2O3-B2O3	0	76.5449	0	94.9874

Discussion: The cited reports develop mathematical models for estimating glass properties. The models have the capability to formulate glasses with realistic waste oxide loading within the envelope of acceptable glass properties.

Issue: These models may not be applicable to the specific melter conditions and product formulations proposed by the private contractor during Phase 1. It is important that the models predict the proper trends in HLW glass volume as a function of feed compositions so that the blending drivers for Phase 2 are valid.

A7.14 HIGH-LEVEL WASTE SOLIDS RETRIEVAL EFFICIENCIES

This item is a:

	Constraint
	Requirement
X	Enabling Assumption
	Simplifying / Modeling Assumption

That applies to the:

X	HLW Staging Plan
	LLW Staging Plan
	Retrieval Sequence / Blending
	Process Flowsheet
	OWVP
X	HTWOS
	DSS Inventory

Text of Item: The best available information regarding the solids removal efficiencies for the DST retrieval systems will be used. The estimated retrieval efficiencies for HLW tanks in Phase 1 feed for the various cases evaluated in this document are shown in Table A-23.

Table A-23. High-Level Waste Solids Retrieval Efficiencies.

Tank	Retrieval efficiency (%)	Tank	Retrieval efficiency (%)
241-AW-103	90	241-AZ-102	80
241-AW-104	90	241-C-107	85[a]
241-AY-101	95	241-C-104	85[a]
241-AY-102	64	241-C-106	83[b]
241-AZ-101	90	241-SY-102	80

[a]Based on projections of 241-C-106 retrieval.
[b]Based on estimated recovery of 1.52m (5 ft) of sludge and leaving 0.3 m (1 ft) of hard pan sludge remaining in 241-C-106.

Source: Grams (1995), Crawford (1999), and Carothers et al. (1999).

Discussion: The actual retrieval efficiencies achieved may vary from the estimated value for each tank. Other retrieval efficiencies may be modeled to evaluate proposed scenarios.

A7.15 HIGH-LEVEL WASTE PRETREATMENT PROCESS LEACH SOLUTION COMPOSITION

This item is a:

	Constraint
	Requirement
X	Enabling Assumption
	Simplifying / Modeling Assumption

That applies to the:

X	HLW Staging Plan
	LLW Staging Plan
	Retrieval Sequence / Blending
	Process Flowsheet
	OWVP
X	HTWOS
	DSS Inventory

Text of Item: The following assumptions are made regarding the composition of sludge wash solutions that will be used by the private contractor during pretreatment of HLW sludge. The HTWOS model accounts for free hydroxide consumption by stoichiometry of the solid to liquid transition, adding sufficient caustic to cover caustic consumption and finish with 3*M* free hydroxide in the leachate. Water wash steps are conducted with 0.11*M* NaOH and 0.1*M* $NaNO_2$.

There may be exceptions to this for specific batches of waste when there is empirical data to optimize leaching for that batch.

Source: Orme and Crawford.

Discussion: The water wash conditions trace back to requirements for doing washing in DSTs. BNFL Inc. is now doing the washing within their facility, so adding this additional sodium needs to be reconsidered.

A7.16 PRIVATE CONTRACTOR PROCESS CHEMISTRY

This item is a:

	Constraint
	Requirement
X	Enabling Assumption
	Simplifying / Modeling Assumption

That applies to the:

	HLW Staging Plan
	LLW Staging Plan
	Retrieval Sequence / Blending
X	Process Flowsheet
	OWVP
	HTWOS
	DSS Inventory

Text of Item: The private contractor's process chemistry will be modeled per the requirements of the privatization contract, and the associated ICDs.

Source: RL (1998) Mod. A012; BNFL ICDs, see Section A11.1 for a list of the ICDs.

Discussion: The separations required of the private contractor are documented in the contract, but the process chemistry within BNFL Inc.'s scope of responsibility to achieve those results is still under development. Limited information is available, but the level of detail is insufficient to track the destination of waste components in BNFL Inc.'s process, or quantify the amount of materials added to the system. In BNFL Inc.'s process, results will be estimated within the broad constraints stated by the privatization contract and associated ICDs.

A7.17 OUT-OF-TANK SUPERNATE CONDITIONING

This item is a:

	Constraint
	Requirement
	Enabling Assumption
X	Simplifying / Modeling Assumption

That applies to the:

	HLW Staging Plan
	LLW Staging Plan
	Retrieval Sequence / Blending
X	Process Flowsheet
	OWVP
X	HTWOS
	DSS Inventory

Text of Item: Specification 7 prohibits feed delivery operations from transferring feeds that have a visible separate organic layer. No Phase 1 feed tank is known to have a separate organic layer, so the requirement has no practical ramifications. Some tanks during Phase 2 will have separate organic liquids. For Phase 2, we assume that the retrieval contractor will have done sufficient characterization of each tank to determine the presence of an organic liquid. A physical separation occurs early in the retrieval flowsheet, e.g., at the satellite retrieval facility or DST sluice tank, so there is no opportunity for the organic to contaminate the balance of the feed delivery system. HTWOS does not track the accumulation or disposition of this organic. It is only discussed in the text of the RPPOUP.

Discussion: The current DQO for LAW feed (Certa and Jo 1998), which came out before this requirement was established, will be revised in the near future to demonstrate how the feed delivery contractor will comply with the requirement to not transfer organic phases. For Phase 1, the practical solution is for pump suctions to be positioned below liquid surface so that floating layers will not be entrained. As noted above, there is no known organic layer in any Phase 1 tank.

Source: RL (1998) MOD. A012 (2000).

A7.18 RADIONUCLIDE SEPARATIONS

This item is a:

	Constraint
	Requirement
	Enabling Assumption
X	Simplifying / Modeling Assumption

That applies to the:

	HLW Staging Plan
	LLW Staging Plan
	Retrieval Sequence / Blending
X	Process Flowsheet
	OWVP
X	HTWOS
	DSS Inventory

Text of Item: During Phase 1, the HTWOS model shows that Sr/TRU, Cs and Tc are separated by BNFL Inc. to satisfy Specification 2 concentration requirements for radionuclides in

ILAW. In addition to the concentration requirement, BNFL Inc. must remove on average a minimum of 80 percent of the ^{99}Tc present in the feed,, which we have interpreted as an overall requirement for Phase 1. During Phase 2, the HTWOS model will use the same radionuclide separations.

Source: RL (1998).

A7.19 PHASE 1B AND 2 IMMOBILIZED LOW-ACTIVITY WASTE COMPOSITION

This item is a:

	Constraint
	Requirement
	Enabling Assumption
X	Simplifying / Modeling Assumption

That applies to the:

	HLW Staging Plan
	LLW Staging Plan
X	Retrieval Sequence / Blending
X	Process Flowsheet
	OWVP
X	HTWOS
	DSS Inventory

Text of Item: The HTWOS model for Phase 1 will estimate the volume of glass based on a number of possible waste loading cases. The first case assumes that the contractor will produce a glass that just meets the minimum Na_2O loading recently proposed for Specification 2.2.2.2. The second case assumes that the contractor will achieve a higher Na_2O loading. The level of loading is provided by guidance from BNFL Inc. and is drawn from the current basis that BNFL Inc. is working from. The third case assumes the Na_2O loading provided by the PIO Guidance. The Na_2O loading in the Phase 1 LAW glass for all cases is presented in Tables A-26 and A-27. Phase 2 LAW glass will have a Na_2O loading of 20 wt% per Feng (1996). A LAW glass density of 2.66 is assumed based on guidance from BNFL Inc.

The volume of LAW glass in an ILAW package is assumed to be 2.3 m^3. This value is based on the 1.4m x 1.4m x 1.4m container size with estimated allowances for internal gussets and contours within the package shown in ICD-15 and a five percent void space provided for in the contract.

Source: Communication with M. Berry of BNFL Inc. (January 1999), Feng et al. (1996), personal communication with Kayle Boomer on February 7, 2000.

Discussion: BNFL Inc. has indicated that they are planning on filling an ILAW package with 6 metric tons of ILAW. This mass corresponds to an 2.23 m^3 glass volume and a glass density of 42.66 MT/m^3.

Table A-24. Assumed Na_2O Loadings in Phase 1 Low-Level Waste Glass.

Envelope	Proposed Spec. 2.2.2.2 minimum Na_2O Loading, weight percent	BNFL Inc. Target [wt% Na_2O] x [wt% SO_3]	PIO Guidance – Minimum wt% Na_2O Loading
Envelope A	14	< 5	19.5
Envelope B	5	< 8	7.5

Envelope C	10	< 5	17.0

Table A-25. Phase 2 Immobilized Low-Activity Waste Glass Formulation Constraints.

Component	Concentration Limit
Al_2O_3	= 12 wt%
B_2O_3	= 5 wt%
CaO	= 4 wt%
Na_2O	= 20 wt%
SIO_2	$ 50 wt%

Table A-26. Key Radionuclide Limits in Low-Activity Waste and Immobilized Low-Activity Waste.

Radionuclide	LAW Limit (Ci/MT LAW Sodium)	ILAW Limit (Ci/m^3)
^{99}Tc	0.25	0.1
^{90}Sr	50.7	20
^{137}Cs	7.60	3

A7.20 HISTORICAL DOUBLE-SHELL TANK VOLUME RECONCILIATION

This item is a:

	Constraint
	Requirement
	Enabling Assumption
X	Simplifying / Modeling Assumption

That applies to the:

X	HLW Staging Plan
X	LLW Staging Plan
X	Retrieval Sequence / Blending
X	Process Flowsheet
X	OWVP
X	HTWOS
X	DSS Inventory

Text of Item: The projected volumes of the DST system as of July 21, 1999, will be adjusted to agree with the actual historical volumes from Hanlon.

Discussion: The HTWOS model includes historical transfers that are needed to prepare projections of the volume and composition of waste in the DST system. Propagation of errors causes discrepancies between the modeled volumes (both the total tank volumes and settled solids volume) and the actual reported volumes. These discrepancies are resolved by adding or subtracting water so that the modeled total volume of each DST matches the reported Hanlon volume. Then the weight percent to which any solids have settled are adjusted so that the slurry volumes agree (keeping the total mass of dry solids constant). This adjustment is also needed to maintain consistency with the OWVP (Strode and Boyles 1999).

A7.21 HIGH-LEVEL WASTE--SLUDGE SETTLING DURING STORAGE

This item is a:

	Constraint
	Requirement
X	Enabling Assumption
	Simplifying / Modeling Assumption

That applies to the:

	HLW Staging Plan
	LLW Staging Plan
X	Retrieval Sequence / Blending
	Process Flowsheet
	OWVP
X	HTWOS
	DSS Inventory

Text of Item: The solids stored in tanks designated for HLW storage will be assumed to settle to 20 wt% insoluble solids after 30 days of settling. There is compacting beyond 20 wt% if time is allowed, but it is not assumed. The solids settling times for compacting beyond 20 wt% in large-scale operations was recently reported (Maclean 2000).

Source: Bench scale testing with actual tank wastes from tanks 241-S-107 (PNNL-12010), 241-C-106 (Brooks et al. 1997), and 241-C-107 (Brooks et al. 1996) support sludge compaction beyond 20 wt%.

Issue: Temperature is usually the limiting factor in storing sludges. The thicker the sludge, the more resistance there is to conduction. The more resistance there is to conduction, the higher the equilibrium temperature within the sludge. The allowable depth of settled solids depends primarily on the self-heating rate. A thermal study is required to determine allowable depth under different self-heating conditions.

Issue: Transfer and consolidation of solids (with the exception of 241-C-106 sluicing) is un-analyzed and not in the Authorization Basis. The activity could affect several identified accidents or add new bounding accidents, resulting in additional Technical Safety Requirement controls.

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A8.0 TANK WASTE INVENTORIES AND COMPOSITIONS

A8.1 INVENTORY AND COMPOSITION BASIS

This item is a:

	Constraint
	Requirement
X	Enabling Assumption
	Simplifying / Modeling Assumption

That applies to the:

X	HLW Staging Plan
X	LLW Staging Plan
X	Retrieval Sequence / Blending
X	Process Flowsheet
X	OWVP
X	HTWOS
	DSS Inventory

Text of Item: The inventories and compositions used for TFC O&UP will be based on the January 11, 2000 Best-Basis Inventory (BBI). This inventory incorporates waste transfers through September 30, 1999 with the exception of tanks 241-C-106 and 241-AY-102, which were updated to July 31, 1999. The feed delivered to the private contractor during Phase 1 will need to be subtracted from this inventory to generate an inventory for Phase 2 processing.

Discussion: The Phase 2 feed for the process flowsheet will be determined by adjusting the BBI to account for the feed delivered to the private contractor during Phase 1.

Issue: The BBI does not cover all the compositions listed in the contract. An assessment of appropriate data source(s) to use to supplement the BBI with this information needs to be performed.

A8.2 DOUBLE-SHELL TANK INVENTORY AND COMPOSITION VERSUS TIME

This item is a:

	Constraint
	Requirement
X	Enabling Assumption
	Simplifying / Modeling Assumption

That applies to the:

X	HLW Staging Plan
X	LLW Staging Plan
X	Retrieval Sequence / Blending
	Process Flowsheet
X	OWVP
X	HTWOS
X	DSS Inventory

Text of Item: DST inventories and compositions will be adjusted to reflect tank activities during the mission. Activities include new waste additions and evaporator operation, Phase 1 HLW and LAW feed staging activities, and SST retrieval. New waste additions after June 1, 2018, were not modeled.

Source: Strode and Boyles (1999); Carothers et al. (1999).

Discussion: The HTWOS model will be used to determine the projected DST inventories and compositions as a function of time.

Issue: Projections are subject to change. Generally, the more complicated the projection, the more likely it is to change. For example, a static tank's projection would be as accurate as the starting inventory, while a tank filled with evaporator bottoms from new tank waste (which may be represented as an average composition) will be less certain.

A8.3 CHARGE BALANCES

This item is a:

	Constraint
	Requirement
	Enabling Assumption
X	Simplifying / Modeling Assumption

That applies to the:

X	HLW Staging Plan
X	LLW Staging Plan
X	Retrieval Sequence / Blending
X	Process Flowsheet
X	OWVP
X	HTWOS
X	DSS Inventory

Text of Item: The charge balancing features of this HTWOS version have been improved. The initial inventory of each tank layer is balanced on DH^-. When wash and leach factors solubilize metals, an equivalent amount of OH^- or $CO3^-$ dissolves. Therefore, the balance in liquid and solid phase is maintained.

Discussion: Material movements in HTWOS are tracked on the basis of mass only, so an imbalance of charges does not preclude exercising the model. As noted above, neither phase should be out of balance unless the initial inventory was unbalanced.

Several manipulations of BBI information are required to prepare data files that are compatible with Environmental Simulation Program (ESP)[2] modeling, one of which is balancing charges. All adjustments to the BBI for tank specific modeling purposes are clearly documented in the tank specific flowsheets.

A8.4 RETRIEVED WASTE COMPOSITIONS

This item is a:

	Constraint
	Requirement
	Enabling Assumption
X	Simplifying / Modeling Assumption

That applies to the:

X	HLW Staging Plan
X	LLW Staging Plan
X	Retrieval Sequence / Blending
X	Process Flowsheet
	OWVP
X	HTWOS
X	DSS Inventory

Text of Item: Waste retrieved from tanks is homogenous. Waste from DSTs may be retrieved in layers; as supernate, mobilized sludge, or as a mobilized salt layer. The wastes in SSTs are retrieved as a slurry of the entire tank contents

[2]ESP is a trademark of OLI Systems, Inc.

Discussion: The wastes in the tanks may not be homogeneous. Variations in stream composition from start to finish are expected. The variation is inconsequential unless it is large enough to adversely impact the transfer.

A8.5 IN-TANK EVAPORATION OF AZ TANK FARM TANKS

This item is a:

	Constraint
	Requirement
X	Enabling Assumption
	Simplifying / Modeling Assumption

That applies to the:

X	HLW Staging Plan
	LLW Staging Plan
	Retrieval Sequence / Blending
	Process Flowsheet
	OWVP
X	HTWOS
X	DSS Inventory

Text of Item: The volume in the aging waste farm should be managed in such a way that the liquid phase in 241-AZ-101 and in 241-AZ-102 is around 5*M* Na and 3.5*M*, respectively, at the time of retrieval. 241-AZ-102 has to be more dilute because there are more solids in that tank.

Source: Orme (1999a) and Orme (1999b).

Discussion: Condensates from the aging waste vent system are routed to one of the four aging waste tanks. Currently, condensates are routed to 241-AZ-102. Then condensates will be routed to 241-AZ-101 unless there is a change in plans. What happens after 241-AZ-101 fills hasn't been determined.

Issue: If 241-AZ-102 continues to be used as a receiver, it is possible that the liquids may not evaporate to the required minimum concentration. A study should examine the options for managing aging waste condensate, and then recommend a plan to ensure that aging waste liquids are within specification on their scheduled delivery date. Tank 241-AY-102 appears to be a better destination because sluicing uses large amounts of water anyway. *The Data Quality Objectives for TWRS Privatization Phase 1: Tank Waste Transfer Control* (Banning 1999) establishes criteria for waste transfers into Phase 1 feed tanks to ensure that Phase 1 feed isn't compromised, but vent system condensates apparently aren't considered a waste transfer.

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A9.0 PHASE 1B INTERFACES

This section addresses Phase 1B interfaces with the exception of certain inputs to the private contractor addressed elsewhere. The exceptions are the LAW Feed, HLW Feed and Waste Feed Tanks, and Feed Delivery all addressed in Section A5.0, and Feed Compositions and Section A4.0. The interfaces in this section are needed to estimate DST tank space demands or affect the mass balances in the TWRS Privatization Process Flowsheet.

A9.1 PHASE 1B MODELED INTERFACES

This item is a:

	Constraint
	Requirement
X	Enabling Assumption
	Simplifying / Modeling Assumption

That applies to the:

X	HLW Staging Plan
X	LLW Staging Plan
X	Retrieval Sequence / Blending
X	Process Flowsheet
X	OWVP
X	HTWOS
	DSS Inventory

Text of Item: Table A-27 identifies all the documents describing the interfaces between the DOE-RL and the private contractor. An "X" in the Modeled column indicates that interface is modeled in HTWOS and tracked in the mass balances.

The highest priority interfaces addressed in TFC O&UP are 14, 15, 16, 19, and 20. BNFL Inc. is the HLW/LAW contractor, so interfaces for cesium and technetium intermediate product are no longer relevant. Additional interfaces that pertain to the material balance (1 and 6) or the contractor's radioactive solid wastes (3 and 13) are discussed to the extent that information is available.

Table A-27. Interface Control Documents. (2 Sheets)

Number	Title	Modeled
1	Raw Water	X
2	Potable Water	
3	Radioactive Solid Wastes	
4	Dangerous Wastes	
5	Non-radioactive, Non-dangerous Liquid Effluents	X
6	Radioactive, Dangerous Liquid Effluents	X
7	Non-Dangerous Solid Wastes	
8	Liquid Sanitary Wastes	
9	Land for Siting	
10	Deactivated Facility and Site	

Table A-27. Interface Control Documents. (2 Sheets)

Number	Title	Modeled
11	Electricity	
12	Roads	
13	Reserved	
14	Immobilized High-Level Waste	X
15	Immobilized Low-Activity Waste	X
16	Entrained Solids	X
17	Reserved	
18	Reserved	
19	Low-Activity Waste Feed	X
20	High-Level Waste Feed	X
21	Reserved	
22	Air Emissions	
23	Waste Treatability Samples	
24	Reserved	
25	Emergency Response	
26	Permits	

Source: RL (1998), as amended.

A9.2 PHASE 1B RETURNS TO DOUBLE-SHELL TANK SYSTEM

This item is a:

	Constraint
	Requirement
X	Enabling Assumption
	Simplifying / Modeling Assumption

That applies to the:

	HLW Staging Plan
	LLW Staging Plan
X	Retrieval Sequence / Blending
X	Process Flowsheet
X	OWVP
X	HTWOS
	DSS Inventory

Text of Item: BNFL Inc. will not return entrained solids to the DST system.

Source: Taylor (1999), PIO (2000).

Discussion: The private contractor could return an "Entrained Solids" product that satisfies ICD-16 and Specification 3 or process the entrained solids and incorporate them into ILAW or IHLW as appropriate.

Issue: The entrained solids final disposition has not been determined.

A9.3 DISTRIBUTION OF LOW-ACTIVITY WASTE INTERMEDIATE STREAMS

This item is a:

	Constraint
	Requirement
	Enabling Assumption
X	Simplifying / Modeling Assumption

That applies to the:

X	HLW Staging Plan
	LLW Staging Plan
	Retrieval Sequence / Blending
	Process Flowsheet
	OWVP
X	HTWOS
	DSS Inventory

Text of Item: For Phase 1, the radionuclides separated from LAW, including strontium and manganese precipitates, will be blended in the next available HLW pretreated feed batch. However, entrained solids are accumulated until Phase 2 processing. For Phase 1B, after the early pretreatment phase and for Phase 2, LAW intermediate waste product streams resulting from LAW processing (Cs, Tc, Sr, TRU, and entrained solids) will be blended in the next available HLW pretreated feed batches to immobilization.

Source: Orme et al. (1996) and PIO (2000).

Discussion: This simplification is necessary since detailed flowsheet and process information is not available.

Issue: The projected composition(s) of the LAW intermediate waste streams will not be accurate until information of the private contractor's separation process is known. Additionally, this assumption may introduce timing problems in that the HLW feed is expected to be used up prior to completion of LAW processing.

A9.4 PHASE 1B HIGH-LEVEL WASTE FEED STAGING INTERFACE

This item is a:

	Constraint
	Requirement
	Enabling Assumption
X	Simplifying / Modeling Assumption

That applies to the:

X	HLW Staging Plan
	LLW Staging Plan
	Retrieval Sequence / Blending
	Process Flowsheet
	OWVP
X	HTWOS
	DSS Inventory

Text of Item: The HLW feed batches will be transferred directly from the 241-AZ-101 or 241-AZ-102, 241-AY-102, 241-AY-101, or 241-AW-104 to the private contractor's facility. through a point of connection at the BNFL site boundary.

Source: ICD 20.

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A10.0 PHASE 2 INTERFACES

A10.1 LIQUID EFFLUENTS TO THE TANK FARMS

This item is a:

	Constraint
	Requirement
X	Enabling Assumption
	Simplifying / Modeling Assumption

That applies to the:

	HLW Staging Plan
	LLW Staging Plan
	Retrieval Sequence / Blending
X	Process Flowsheet
	OWVP
	HTWOS
	DSS Inventory

Text of Item: No radioactive liquid effluents from Phase 2 private plants will be discharged to the tank farms even though the FY 1999 MYPP allows such discharges until through 2024. Liquid effluents will receive sufficient treatment to be accepted at the Effluent Treatment Facility (ETF).

Source: Ron Orme; There is no contractual guidance available for Phase 2.

Discussion: The implication of the MYPP is that the Phase 2 private plants do not have to have internal capability to treat liquid to ETF and Treated Effluent Disposal Facility (TEDF) feed specifications at the beginning (2011). There is, however, no guidance on how much or how bad the returns can be before 2024.

A10.2 NEW WASTE RECEIPTS

This item is a:

	Constraint
	Requirement
X	Enabling Assumption
	Simplifying / Modeling Assumption

That applies to the:

	HLW Staging Plan
	LLW Staging Plan
X	Retrieval Sequence / Blending
X	Process Flowsheet
X	OWVP
X	HTWOS
	DSS Inventory

Text of Item: Numerous waste transfers are anticipated from various sources into DSTs. Current waste generators are WESF, B-Plant, PFP, PUREX, S-Plant, T-Plant, TFO, evaporators, 100 Areas, 300/400 Area Labs, and Inactive Miscellaneous Underground Storage Tanks (IMUSTs). These transfers are modeled to occur at various intervals per year and to continue for an explicit time span in years. The list of waste generators is taken from the OWVP (Strode and Boyles 1999).

Currently a volume only is included for the IMUSTs. Specifics of composition will be modeled as details become available. The requirement for IMUST retrieval is that the IMUSTs are to be retrieved with the SSTs from the associated tank farm.

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A11.0 ARCHITECTURE

A11.1 PHASE 1B PRIVATIZATION SERVICES

This item is a:

	Constraint
	Requirement
X	Enabling Assumption
	Simplifying / Modeling Assumption

That applies to the:

X	HLW Staging Plan
X	LLW Staging Plan
X	Retrieval Sequence / Blending
X	Process Flowsheet
X	OWVP
X	HTWOS
	DSS Inventory

Text of Item: BNFL Inc. will provide both LAW and HLW services in Phase 1. BNFL Inc. will process the contract minimum order quantities and the contract will be modified to include an extended order quantity.

Source: RL (1998) MOD. A012.

Issue: Reduction in the assumed services or amount of waste processed may have significant impacts on the timing of SST retrieval or other activities that require DST space during Phase 1 or early Phase 2.

A11.2 PHASE 2 PRIVATIZATION SERVICES

This item is a:

	Constraint
	Requirement
	Enabling Assumption
X	Simplifying / Modeling Assumption

That applies to the:

	HLW Staging Plan
	LLW Staging Plan
X	Retrieval Sequence / Blending
	Process Flowsheet
X	OWVP
X	HTWOS
	DSS Inventory

Text of Item: Phase 2 LAW services will be modeled as two different facilities. Phase 2 HLW services will be modeled as one expanded facility.

Discussion: The direction to have two Phase 2 HLW facilities was not received in time to add a second HLW facility to the model.

A11.3 WASTE TRANSFER SYSTEM UPGRADES

This item is a:

	Constraint
	Requirement
X	Enabling Assumption
	Simplifying / Modeling Assumption

That applies to the:

X	HLW Staging Plan
X	LLW Staging Plan
X	Retrieval Sequence / Blending
	Process Flowsheet
X	OWVP
X	HTWOS
	DSS Inventory

Text of Item: The waste transfer system upgrades, intermediate feed staging tank upgrades and upgrades to the source DSTs and the aging waste tanks will be available in time to support staging of feed for both LAW and the HLW facilities. Current operational need dates are given in Table A-28.

Table A-28. Phase 1 System Upgrade Need Dates.

Tank where system is needed	Operational-need date
AN-101	5/04
AN-102	6/07
AN-103	5/11
AN-104	12/04
AN-105	10/09
AN-107	4/09
AP-101	8/04
AP-102	10/06
AP-104	11/04
AP-105	9/154
AP-106	3/14
AP-108	4/16
AW-101	3/12
AW-103	2/07
AW-104	12/12
AY-101	4/07
AY-102	4/07
AZ-101	12/04
AZ-102	1/05
C-104	4/07
C-107	11/09
S-102	2/13
S-105	5/13
SY-101	11/10
SY-102	9/09
SY-103	11/12

Source: Drawings RPP-5742 and RPP-5836.

Discussion: Operational-need dates were established using RPP Key Planning Assumptions, projected vitrification processing dates, and project schedule considerations.

A11.4 NUMBER OF WASTE RETRIEVAL FACILITIES

This item is a:

	Constraint
	Requirement
X	Enabling Assumption
	Simplifying / Modeling Assumption

That applies to the:

	HLW Staging Plan
	LLW Staging Plan
X	Retrieval Sequence / Blending
	Process Flowsheet
	OWVP
X	HTWOS
	DSS Inventory

Text of Item: Three Waste Retrieval Facilities (WRFs) will be required. One is required for each of the Northern quadrants, and one is required for the U Tank Farm. Wastes in the Southeast (SE) quadrant, and Southwest (SW) quadrants (other than the U Tank Farm) can be retrieved directly to DSTs.

Discussion: For the SW quadrant to be retrieved within a reasonable schedule, waste must be retrieved from all three farms simultaneously. There are only three DSTs in the southwest quadrant, and one of them needs to be used as a cross site transfer tank for waste from the NW quadrant. Therefore, a waste retrieval facility is needed to support timely retrieval of the U Tank Farm wastes.

A11.5 WASTE RETRIEVAL FACILITY AVAILABILITY

This item is a:

	Constraint
	Requirement
X	Enabling Assumption
	Simplifying / Modeling Assumption

That applies to the:

	HLW Staging Plan
	LLW Staging Plan
X	Retrieval Sequence / Blending
	Process Flowsheet
	OWVP
X	HTWOS
	DSS Inventory

Text of Item: The Northern quadrant WRFs are available on 10/1/2011. The U Tank Farm WRF is available on 1/1/2009.

Discussion: These WRF availability dates were used to back fill DSTs within assumed equipment constraints to support completion of processing by 2030.

Source: Acree (1998).

Issue: The SST program was developed using guidance for the unconstrained scenario and does not have funding or projects identified to support the 2030 completion date. It is possible that the schedule for the WRFs could be delayed and that processing could be completed by 2030. Further analysis is needed to establish need dates for the WRFs.

A11.6 WASTE RETRIEVAL FACILITY CONFIGURATION

This item is a:

	Constraint
	Requirement
X	Enabling Assumption
	Simplifying / Modeling Assumption

That applies to the:

	HLW Staging Plan
	LLW Staging Plan
X	Retrieval Sequence / Blending
	Process Flowsheet
	OWVP
X	HTWOS
	DSS Inventory

Text of Item: Each of the WRFs will be modeled as follows:

1. The WRFs for the NE and NW quadrants will contain six tanks with an operating volume of 568 m^3 (150,000 gal). The WRF for U Tank Farm will contain two tanks with an operating volume of 568 m^3 (150,000 gal).

2. Each WRF tank may receive waste from 1 SST at any time. See sections A6.1, A6.2, and A11.5 for more details.

3. Transfers from WRFs will not occur until a total of 0.568 m^3 (150,000 gal) is available to transfer. (An exception will be upon completion of retrieval of waste from the quadrant associated with a WRF.)

Issue: The configuration for the WRFs is not known. The modeled configuration is based upon preliminary information regarding the amount of waste that should be transferred to limit the flush solutions to a reasonable volume.

A11.7 INTERMEDIATE FEED STAGING TANK UPGRADES

This item is a:

	Constraint
	Requirement
X	Enabling Assumption
	Simplifying / Modeling Assumption

That applies to the:

	HLW Staging Plan
X	LLW Staging Plan
	Retrieval Sequence / Blending
	Process Flowsheet
	OWVP
	HTWOS
	DSS Inventory

Text of Item: The DSTs will need the following equipment to stage LAW feed to BNFL Inc.:

- A mixer pump
- A decant pump (if entrainment of solids is expected to be a problem)
- A fixed intake pump if there is no concern about solids entrainment (i.e., the waste contains less than 2 wt% solids)

Source: Galbraith and Daling (1997).

A11.8 SLUICING RECEIVER TANK FOR RETRIEVAL OF THE SOUTHEAST QUADRANT (A, AX, AND C FARMS)

This item is a:

	Constraint
	Requirement
X	Enabling Assumption
	Simplifying / Modeling Assumption

That applies to the:

X	HLW Staging Plan
	LLW Staging Plan
X	Retrieval Sequence / Blending
	Process Flowsheet
	OWVP
X	HTWOS
	DSS Inventory

Text of Item: The current plans are to retrieve 241-C-104 into 241-AY-101 and 241-C-107 into 241-AY-102 using the sluicing line installed for the 241-C-106 demonstration retrieval. This minimizes the costs for retrieving those tanks. In addition, 241-AY-102 appears to be the logical choice for a sluicing receiver for all of the tanks in that quadrant. Therefore, it will be modeled as the sluicing receiver for the southeast quadrant.

Discussion: The minimum order quantity feed for the Phase 1B HLW facility will not be met without additional feed from SSTs. Therefore, an evaluation of the waste quality and composition of selected SSTs was performed. Tank 241-C-104 was selected for providing HLW feed because of the large quantity of post-washing non-volatile oxides projected and its composition. The pipeline to transfer 241-C-106 to 241-AY-102 can be modified at minimal cost to allow the waste from 241-C-104 to be retrieved into 241-AY-101.

A11.9 SINGLE-SHELL TANK RETRIEVAL ARCHITECTURE

This item is a:

	Constraint
	Requirement
	Enabling Assumption
X	Simplifying / Modeling Assumption

That applies to the:

	HLW Staging Plan
	LLW Staging Plan
X	Retrieval Sequence / Blending
	Process Flowsheet
	OWVP
X	HTWOS
	DSS Inventory

Text of Item: Waste retrieval from SSTs will be modeled as if it were done using past practice sluicing.

Discussion: Past practice sluicing approximates the volume of waste which will be obtained from hydraulic methods because of the limits on sodium molarity and solids content allowed for transfers (See Section A7.10). The SST Retrieval program is investigating other SST retrieval technologies and architectures that are expected to perform as well as past practice sluicing. Information on the performance of alternate technologies can be incorporated into the model as it becomes available.

Issue: Retrieval architecture has not been determined. Past practice sluicing may not be appropriate for SSTs that are known or suspected to have leaked.

A11.10 RPP IMMOBILIZED LOW-ACTIVITY WASTE DISPOSAL FACILITY AVAILABILITY

This item is a:

	Constraint
X	Requirement
	Enabling Assumption
	Simplifying / Modeling Assumption

That applies to the:

	HLW Staging Plan
	LLW Staging Plan
	Retrieval Sequence / Blending
	Process Flowsheet
	OWVP
X	HTWOS
	DSS Inventory

Text of Item: BNFL Inc. will deliver the ILAW product in 1.22 m diameter by 2.28 m right cylindrical packages. The side-wall of each package is 0.343 cm (10 gauge) steel. The containers are assumed to be filled to 90% of the 2.51 m^3 internal volume. Assuming that the packages are filled to 90% of the internal volume, each package will hold 2.23 m^3 of glass.

The ILAW disposal facility will be provided by Project W-520. Construction of Project W-520 is scheduled to be completed September 1, 2007 with the first shipment received in December 2007. The facility consists of a series of near-surface disposal modules that are constructed on an as-needed basis. The Phase 1 capacity is 13,366 ILAW packages and the total capacity is 80,196 ILAW packages. The HTOWS model has not been constrained by these limits.

Source: CHG letter # 0000320, Cusak to Poppiti, February 8, 2000, March 8, 2000 PIO Guidance, DOE letter to DeLozier, December 8, 1999, correspondence # LHMC 9958849.

A11.11 RPP CANISTER STORAGE BUILDING AVAILABILITY

This item is a:

	Constraint
X	Requirement
	Enabling Assumption
	Simplifying / Modeling Assumption

That applies to the:

	HLW Staging Plan
	LLW Staging Plan
	Retrieval Sequence / Blending
	Process Flowsheet
	OWVP
X	HTWOS
	DSS Inventory

Text of Item: The CSB will be ready on September 1, 2009 to receive and store IHLW canisters. The maximum Phase 1 IHLW order quantity is 1120 canisters.

Source: PIO (2000).

Discussion: Project W-464 will modify vaults 2 and 3 of the CSB to allow storage of the HLW packages. Vaults 2 and 3 of the CSB will provide space for 440 tubes that could hold 1,320 of the 3-m (10-ft) canisters or 880 of the 4.5-m (15-ft) canisters. These canisters can contain IHLW, cesium, or non-routine HLW. Other CSB availability dates may be modeled to evaluate proposed scenarios. Additional IHLW canister storage space will be constructed on an as-needed basis.

Issue: The operational need dates for the disposal facilities and storage buildings were established from previous evaluations or from the latest programmatic planning. The efforts associated with the TFC O&UP will predict new need dates for those facilities. Those updated need dates will be used to develop new project schedules.

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